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ABSTRACT

The State Criminal Justice Teleccmmunicaticns (STACOM) project has developed techniques for the identification and analysis of user requirements and designs fcr netwcrks fcr the dissemination of criminal justice informaticn on a state-wide basis. Techniques developed fcr user requirements analysis include methods for determining data required, data collection, data organizaticn, and forecasting the volume of network traffic. Network design techniques center arcund a computerized program that enatles the user to generate least cost network topologies that satisfy network requirements for traffic, response time, and other specified functions. Results of the application of these techniques in Texas and Ohio are reported. (Author/CMV)

State Criminal Justice Telecommunications (STACOM) Final Report

Volume I: Executive Summary

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FOREWORD

The State Criminal Justice Telecommunications, (STACOM), Project consists of two major study tasks. The first entails a study of criminal justice telecommunication system user requirements and system traffic requirements through the year 1985. The second investigates least cost network alternatives to meet these specified traffic requirements.

Major documentation of the STACOM Project is organized in four volumes as follows:

Title	Document No.
State Criminal Justice Telecommunications (STACOM) Final Report - Volume I: Executive Summary	77-53 Vol. I
State Criminal Justice Telecommunications (STACOM) Final Report - Volume II: Requirements Analysis and Design of Ohio Criminal Justice Telecommunications Network	77-53 Vol. II
State Criminal Justice Telecommunications (STACOM) Final Report - Volume III: Requirements Analysis and Design of Texas Criminal Justice Telecommunications Network	77-53 Vol. III
State Criminal Justice Telecommunications (STACOM) Final Report - Volume IV: Network Design Software Users' Guide	77-53 Vol. IV

The above material is also organized in an additional four volumes which provide a slightly different reader orientation as follows:

Title	Document No.
State Criminal Justice Telecommunications (STACOM) Functional Requirements - State of Ohio	5030-43*
State Criminal Justice Telecommunications (STACOM) Functional Requirements - State of Texas	5030-61*
State Criminal Justice Telecommunications (STACOM) User Requirements Analysis	5030-80*
State Criminal Justice Telecommunications (STACOM) Network Design and Performance Analysis Techniques	5030-99*

*Jet Propulsion Laboratory internal document

This document, No. 77-53, Volume I, entitled "Executive Summary," describes, in summary form, the methodologies and results of the user requirements analysis and state criminal justice communications network design tasks of the STACOM project. It summarizes the more detailed descriptions and results found in volumes II (Ohio results), III (Texas results), and IV (network design software users' guide) of this final report.

It presents the results of one phase of research carried out jointly by the Jet Propulsion Laboratory, California Institute of Technology, and the States of Ohio and Texas. The work at the Jet Propulsion Laboratory was performed by the Systems Division, Telecommunications Science and Engineering Division, and Information Systems Division under the cognizance of the STACOM Project. The project is sponsored by the Law Enforcement Assistance Administration, Department of Justice, through the National Aeronautics and Space Administration (Contract NAS7-100).

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Texas

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Jack Martine	Department of Public Safety
Chief H. W. McFarling	Department of Public Safety
Chief Glen H. McLaughlin	Department of Public Safety
Vernon Strey	Department of Public Safety

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

APB	All points bulletin
BCII	Ohio Bureau of Criminal Identification and Investigation
BMV	Ohio Bureau of Motor Vehicles
BPP	Texas Boards of Pardons and Paroles
bps	Bits per second
CCH	Computerized Criminal Histories
CDS	Comprehensive Data System
CJIS	Criminal Justice Information System
CLEAR	Hamilton County, Ohio (Cincinnati) County Law Enforcement Applied Regionally
CRT	Cathode ray tube
DEA	United States Drug Enforcement Agency
DHS	Ohio Department of Highway Safety
DPS	Texas Department of Public Safety
FINDER	Calspan Technology Products, Inc., registered trademark for Fingerprint Detector Readers
FBI	Federal Bureau of Investigation
ICR	Identification and Criminal Records Division of Texas Department of Public Safety
LEAA	Law Enforcement Assistance Administration
LEADS	Ohio Law Enforcement Automated Data System
LIDR	Texas License Identification and Driver Registration
MDT	Mobile Digital Terminal
MVD	Texas Motor Vehicle Division
NALECOM	National Law Enforcement Telecommunications
NCIC	National Crime Information Center
NCJISS	National Criminal Justice Information and Statistics Service

NILECJ	National Institute of Law Enforcement and Criminal Justice
NLETS	National Law Enforcement Telecommunications System
NORIS	Lucas County, Ohio (Toledo) Northwest Ohio Regional Information System
OBSCIS	Offender Based State Corrections Information System
OBTS	Offender Based Transaction Statistics
OCCA	Omnibus Crime Control Act of 1968
OCH	Ohio Criminal History
ODRC	Ohio Department of Rehabilitation and Corrections
OSP	Ohio State Patrol
PD	Police Department
RCC	Regional Computing Center
RCIC	Regional Crime Information Center
RSC	Regional Switching Center
SEARCH	System for Electronic Analysis and Retrieval of Criminal Histories
SGI	Search Group, Inc.
SIFTER	System for Identification of Fingerprints by Technical Search of Encoded Records
SJIS	State Judicial Information System
SO	Sheriff Office
SPA	State Planning Agency
STACOM	State Criminal Justice Communications
TCIC	Texas Crime Information Center
TDC	Texas Department of Corrections
THP	Texas Highway Patrol
TJC	Texas Judicial Council
TLETS	Texas Law Enforcement Telecommunications System

TYC	Texas Youth Council
UCR	Uniform Crime Reports

ABSTRACT

An executive overview is provided in Volume I of the Final Report for the major study components and a summary of a State Criminal Justice Telecommunications (STACOM) project sponsored by the Law Enforcement Assistance Administration (LEAA).

The project has developed techniques for identifying user requirements analysis and network designs for criminal justice networks on a state wide basis. Techniques developed for user requirements analysis involve methods for determining data required, data collection, (surveys), and data organization procedures, and methods for forecasting network traffic volumes. Developed network design techniques center around a computerized topology program which enables the user to generate least cost network topologies that satisfy network traffic requirements, response time requirements and other specified functional requirements.

The developed techniques were applied in the states of Ohio and Texas and results of these studies are presented.

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FIGURES

TABLES

SECTION 1

INTRODUCTION

te Criminal Justice Telecommunications, (STACOM), ed techniques for identifying user requirements < designs for criminal justice networks on a statewide developed for user requirements analysis involve iing data required, data collection, (surveys), on procedures, and methods for forcasting network eveloped network design techniques center around logy program which enables the user to generate opologies that satisfy network traffic requirements, rements and other specified functional requirements. oject, these techniques were applied in two model cas. This document provides an executive overview ojectives, a brief description of the analytic tech- id a summary of application results in the two model

. JUSTICE NETWORK COMPONENTS

ilized statewide digital criminal justice telecommuni- lepicted in Figure 1-1. Network system terminations gh regional switching centers, (RSC), to data base general case, RSCs service the system terminations in orward and receive messages to and from central base facilities. The use of a single RSC in the net- RSCs is determined by cost and performance factors. necting a number of terminals on a common transmission opping, as shown in the Figure 1-1, is a typical line costs when applicable.

JUSTICE NETWORK FUNCTIONS

function of statewide digital criminal justice etworks is to process inquiry/response messages agencies to and from centralized state and national . Compatibility for point-to-point transmission of ges is also provided. In law enforcement applications, ta base inquiries initiated by field officers is of Work carried out in Ohio and Texas suggests that a le digital criminal justice networks by law enforcement accessing of vehicle related files. This emphasis emergence of a need not previously envisioned, isions which have knowingly, (or unknowingly), is traffic growth in this direction. In either that inquiry traffic into vehicle related files of criminal justice networks merits further analysis administrators as it may provide a focal point f network cost effectiveness. Other law enforcement

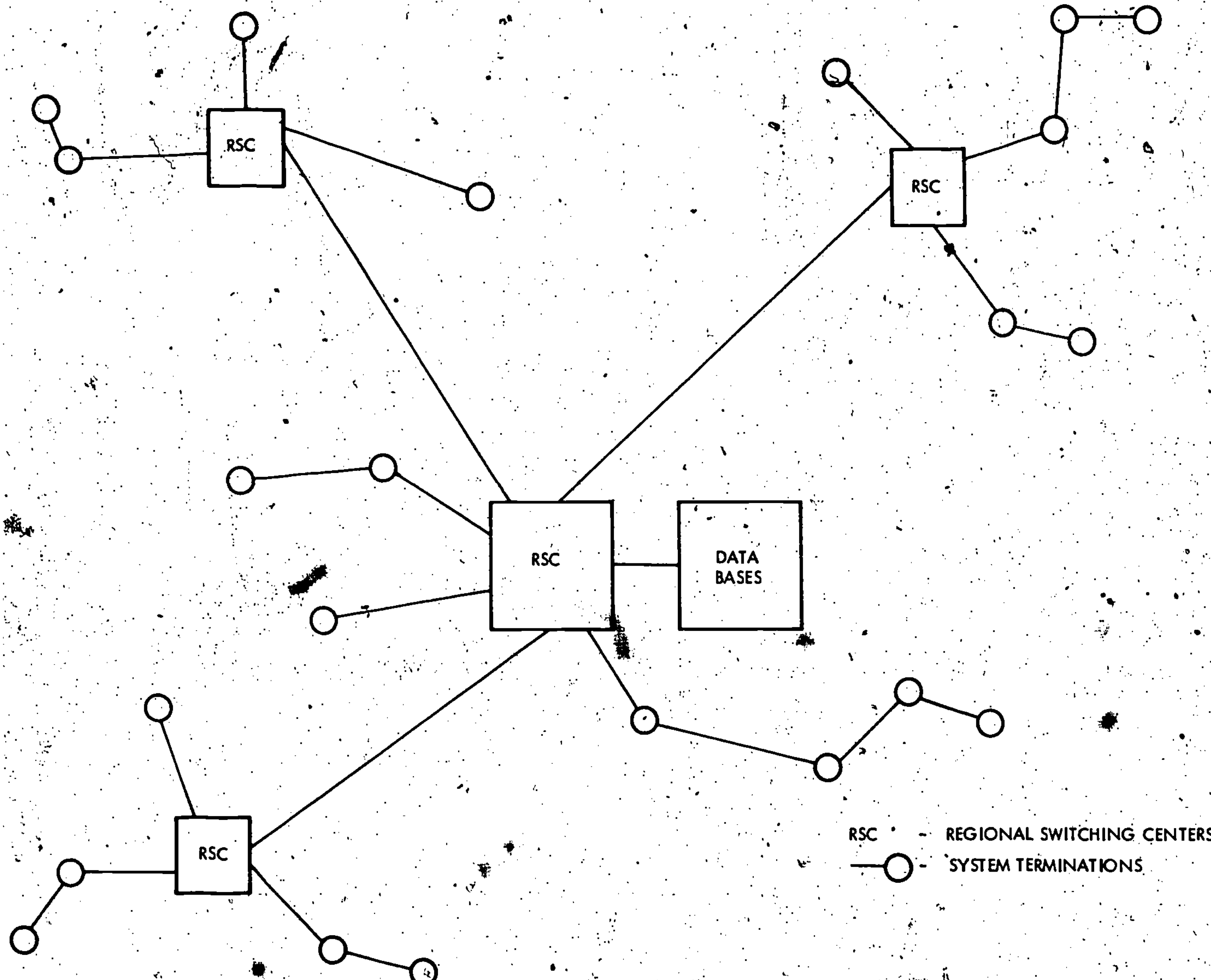


Figure 1-1. A General Communications Network

uses include inquiries into files containing data on drivers licenses, stolen property, wants/warrants and computerized criminal histories. Criminal justice agencies other than law enforcement agencies use statewide criminal justice communication networks primarily for access to CCH, SJIS, OBSCIS, and OBTS functions.

1.3 STACOM PROJECT OBJECTIVES

The STACOM Project objectives are:

(1) To develop and document techniques for intrastate traffic measurement, analysis of measured data, and prediction of traffic growth.

(2) To develop and document techniques for intrastate network design, performance analysis, modeling and simulation.

(3) To illustrate applications of network design and analysis techniques on typical existing network configurations and new or improved configurations.

(4) To develop and illustrate a methodology for establishing priorities for cost effective expenditures to improve capabilities in deficient areas.

To support these overall project goals, an exercise was undertaken to develop and apply procedures for predicting future criminal justice communications traffic. These procedures include techniques of statistical analysis for extrapolating past trends into future traffic predictions, and survey and interviewing techniques for estimating future traffic in data types that do not yet exist. The effort was therefore divided into two phases: a study of past trends in existing data types to project future trends in communications traffic for these data types; and a study of new data types that do not yet exist, but which are anticipated, to estimate their future traffic volume.

In addition, a Network Functional Requirements document was developed which specifies in detail what the network must do to meet user requirements. These specifications include traffic levels which must be handled, desired response times, system availability goals and other performance requirements.

Network designers then used the developed functional requirements to study future intrastate network optional designs that minimize cost and still satisfy performance requirements. Knowing estimated traffic volumes over a decade, network designers can also suggest the best times to upgrade computers or communication lines to maintain performance within required limits and assure minimum costs.

The developed analysis and design techniques have been applied in the States of Ohio and Texas leading to new or improved network designs.

Finally, a major STACOM objective has been to document the developed analysis and design techniques with the goal of providing a guide for other states to carry out similar studies.

1.4 STACOM RESULTS

Traffic predictions and major network design findings resulting from the STACOM Project are as follows.

1.4.1 Traffic Forecasts

Statewide criminal justice information system traffic projections in average messages per day for the states of Ohio and Texas are presented in Figures 1-2 and 1-3.

The major contributors to traffic totals are the existing law enforcement data types and law enforcement use of CCH/OBTS data.

1.4.2 Network Design

In both the States of Ohio and Texas, the least cost statewide network, among options considered, consists of a single switcher data base facility located at the state capitol serving system terminations throughout the state over multidropped communication lines. In both cases, line savings due to the use of distributed regional switchers are not sufficient to offset additional costs incurred for regional switcher hardware, sites, personnel, interregion lines and increased engineering costs.

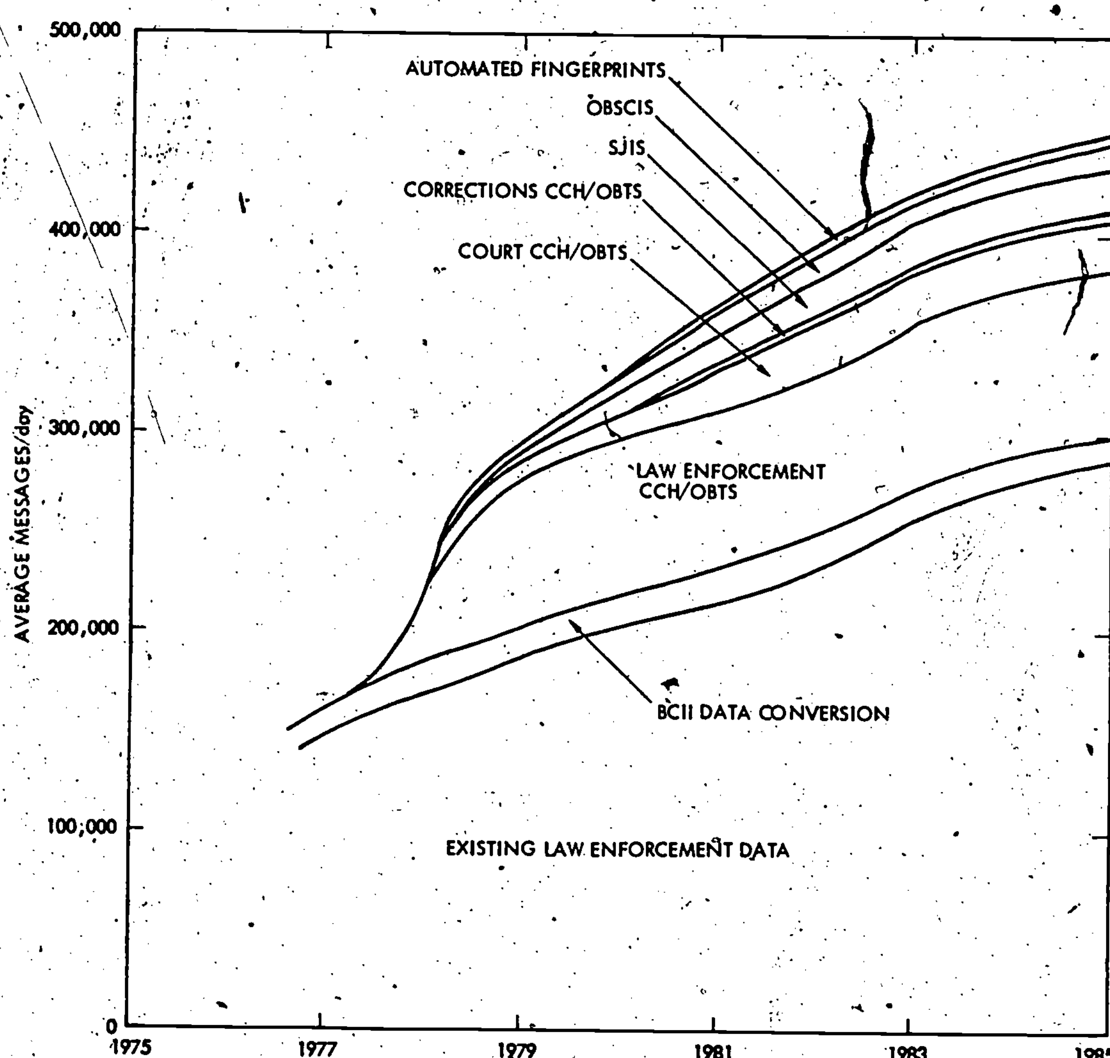


Figure 1-2. Ohio Statewide Criminal Justice Information System Traffic Projection in Average Messages per Day

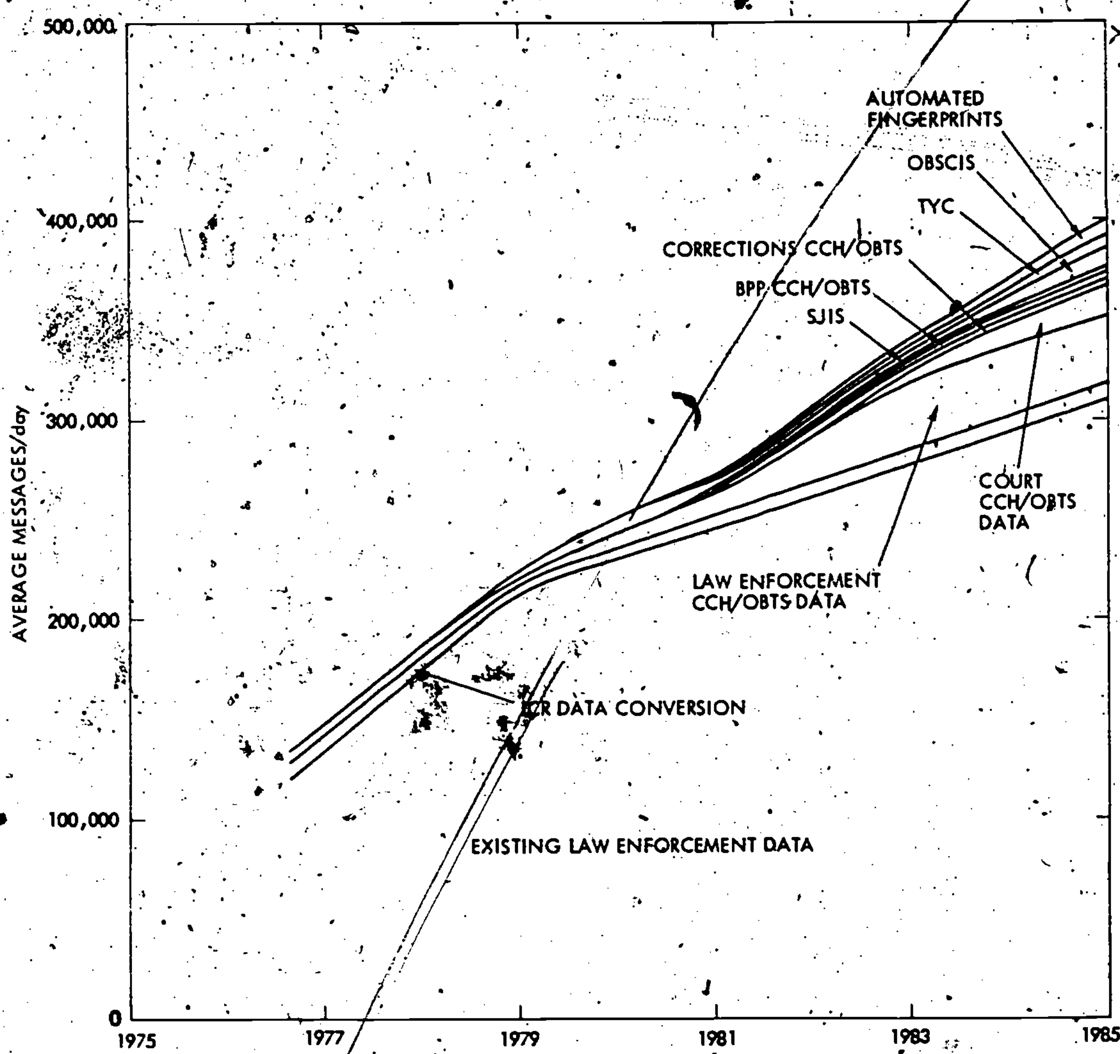


Figure 1-3. Texas Statewide Criminal Justice Information System Traffic Projection in Average Messages per Day

SECTION 2

USER REQUIREMENTS

In order to design communications and computer facilities that will satisfy states needs over a number of years, it is necessary to project future user needs. User needs are meaningful to system designers in two forms. The first expresses the demand on the system and is given in terms of the amount of communication traffic to be transmitted over the state criminal justice telecommunication system. The second is the level of performance required of the system which includes measures such as required response times, and required system availability. Given these two forms of user requirements, designers can devise systems that handle the communications traffic while operating at required performance levels.

Paragraph 2.1 of this report describes the methods used to determine current communication message volumes and the methods used in predicting future message volumes. Basic steps of these methods are:

(1) Determination of required data

(2) Data collection

(3) Data organization

(4) Development of forecasting techniques

(5) Application of forecasting techniques

Since there are always uncertainties contained in forecasts it becomes necessary for the analyst to make assumptions about future events. The major assumptions required for each of the above steps will be emphasized.

Paragraph 2.2 discusses required performance levels of the state criminal justice telecommunications system. The steps required to establish these functional requirements as well as a statement of the requirements in the two model states will be presented.

Two categories of future communication traffic were defined. The first was future traffic into existing data bases and the second was future traffic into new data bases. Because of differences in the availability of operations information, two distinct methods were used to predict future message volumes of these message categories. Subsequent discussions will thus separate into existing data types and new data type sections.

2.1 MESSAGE VOLUME DETERMINATION

2.1.1 Existing Data Types

2.1.1.1 Determination of Required Data

To determine current message volumes and to forecast future message volumes the following categories of information are required.

(1) A historical description of the state criminal justice telecommunications system.

(2) Statistics on past and current message volumes and message characteristics.

(3) Operational policies that impact traffic levels.

(4) Planned upgrades or changes to the communication system that may impact traffic levels.

The historical system description should cover the last five years and include information on types of records maintained, a list of system users, topology of the communication network, and the location of major system components. Changes to the system configuration having major impacts on traffic volume should be carefully documented.

Past traffic statistics should also be obtained for the previous five years. Both the number of communication messages and the number of computer transactions are required. It is necessary to break out messages by type, and the distribution of messages to system users is also needed. Message length by message type is required.

Any operational policies that impact traffic volume should be identified. Examples are automatic generation of messages by computer or restrictions to entry of data bases.

Finally any planned improvements to the system or changes to the operating procedures that would increase traffic must be known. Possible examples are replacement of low speed communication lines with high speed lines, addition of new system users, or addition of new record types.

2.1.1.2 Data Collection

Data collection was accomplished by the use of surveys. Surveys were directed to the state agency responsible for operating the state criminal justice telecommunications system, to the state criminal justice planning agency and to system users. The operating agency provided information on system description, traffic statistics, message characteristics, and operational policies. State planning agencies have traditionally provided funding for system upgrades and thus provided information on planned future improvements. Finally

user agencies verified the traffic statistics and provided a qualitative statement of the effectiveness of the state system in meeting their needs.

2.1.1.3 Data Organization

Data collected from the above sources were organized to provide the following products:

(1) An historical traffic growth curve which shows traffic levels each month for the last five years

(2) Descriptions of the communication system over the last five years. Complete system descriptions are given for quarterly periods over the past 5 years including information on data base contents and sites, switcher sites, communication line topology, and lists of system users

(3) Overall system message lengths

(4) Distributions of traffic by message type for each month over the last five years

(5) Distributions of traffic by user agency for the last 3 months of available traffic statistics

The experiences with the model states in data organization suggest that extreme care must be taken in the analysis of traffic data. Problems encountered included inconsistencies in definitions, changes over time in methods of collecting traffic statistics and errors in computer statistics gathering packages. Because of these problems it is important for the analyst to work closely with state agency personnel responsible for using and maintaining the traffic statistics. It is also advisable to validate traffic levels by using independent data sources. Unfortunately this is not always possible. An example of a case where validation is possible concerns national traffic where the amount of traffic recorded by the state as being sent to national systems should equal the amount of traffic recorded by the national system as coming from the state.

2.1.1.4 Forecasting Techniques

The basic forecasting framework postulates that past traffic growth is caused by two factors. The first is an increased demand by users and the second is communication system improvements. We assume that growth in traffic due to the first factor will continue in the future as it has in the past. However, growth in traffic due to communication system improvements will depend on the rate of future system improvements. The estimates of these two components of traffic are combined to form the prediction of total future communication traffic levels into existing data types.

The historic traffic growth curve is analyzed to determine the fraction of growth caused by increased utilization, called baseline growth, and the fraction of growth caused by system improvements. The impacts of systems improvements are assessed by measuring sudden increases in traffic immediately following the improvement. Future traffic forecasts are obtained by projecting forward the baseline growth curve and by surveying state planners regarding future system improvements. It is assumed that traffic increases in the future due to a specific improvement will be proportional to traffic increases in the past when that improvement was made.

Once total traffic is forecast, the analyst must distribute this traffic to the many system users. It is assumed that all traffic flows between user agencies and data bases. Relevant characteristics were collected for all criminal justice agencies and relationships were developed between traffic volumes and user characteristics. These experiences were then used to distribute future traffic as a function of future user characteristics.

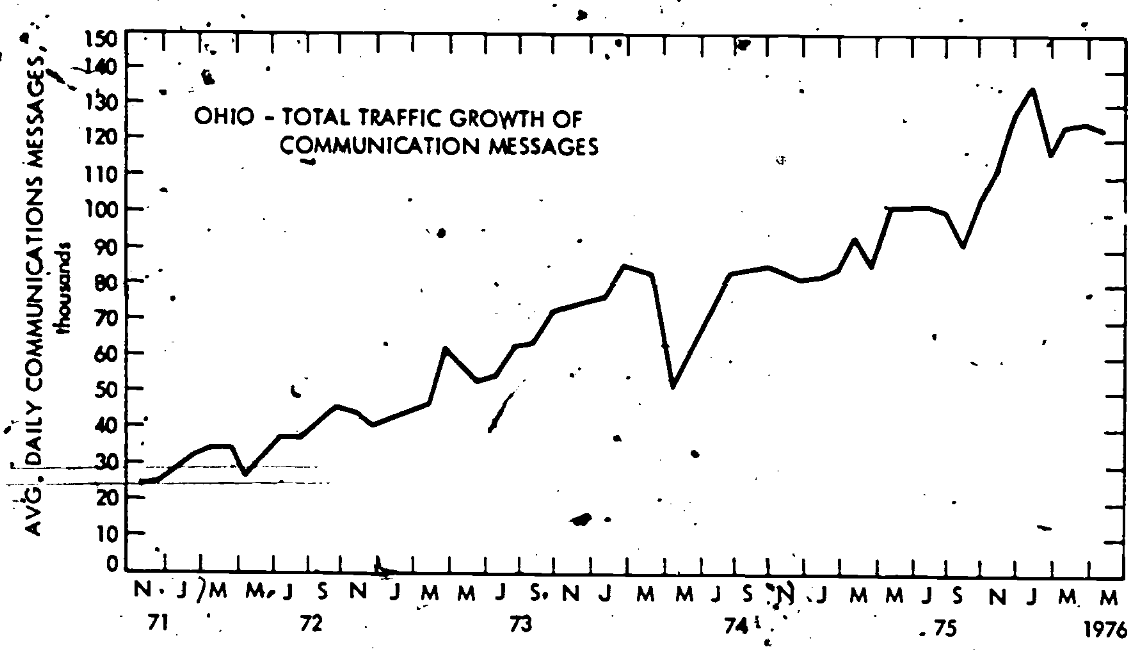
2.1.1.5 Application of Forecasting Techniques

Figure 2-1 shows the historic growth patterns of communication messages in the model states of Ohio and Texas. Over the last five years both states have experienced continual and substantial traffic growth. Figure 2-2 displays the causes of the substantial growth in traffic in Ohio and Texas. Baseline growth in both states accounts for approximately half the traffic increase. System improvements included the conversion to high speed communication lines and terminals, the addition of new users, the addition of new data bases, the implementation of mobile digital terminals, the automatic generation of messages to the National Crime Information Center and the implementation of regional information systems.

Baseline growth curves were projected forward as shown in Figure 2-3. Straight line approximations were used with two different growth rates. The higher growth rate was projected to occur when growth is not constrained by system capacity with the slower growth rate occurring when actual traffic is close to system capacity. It is assumed that there will only be short periods of time in the future where growth is constrained by system capacity.

Surveys of state planners identified the following future system improvements: Addition of new users, conversion to high speed communication lines and terminals, implementation of regional information systems, implementation of mobile digital terminals, and message handling changes. Table 2-1 shows the effects of these system improvements on future traffic in Ohio and Texas.

Baseline traffic growth is combined with growth due to system improvements and growth in new data type messages to predict total system traffic. System capacity acts as a constraining factor on total system growth.



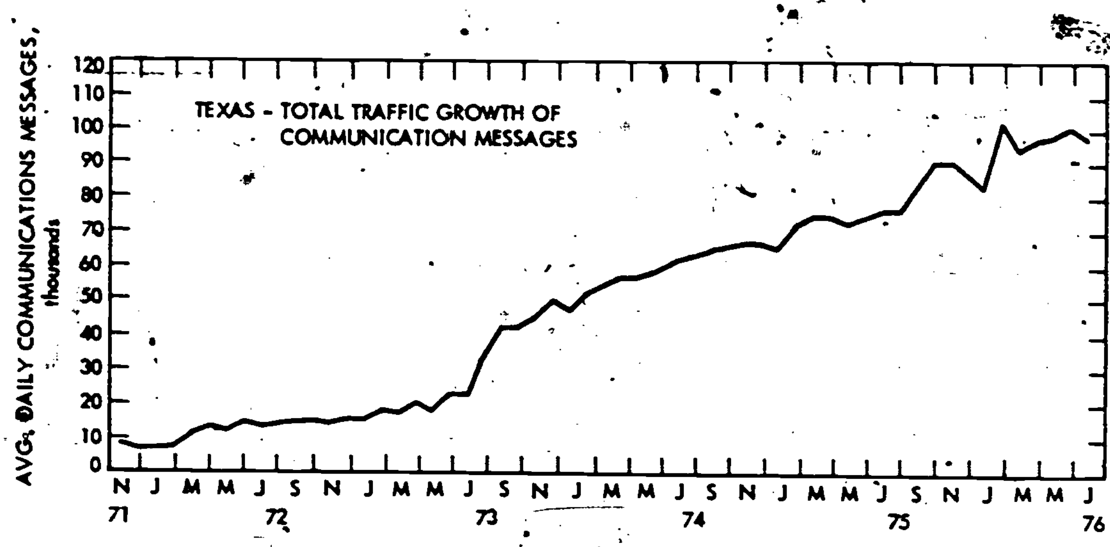
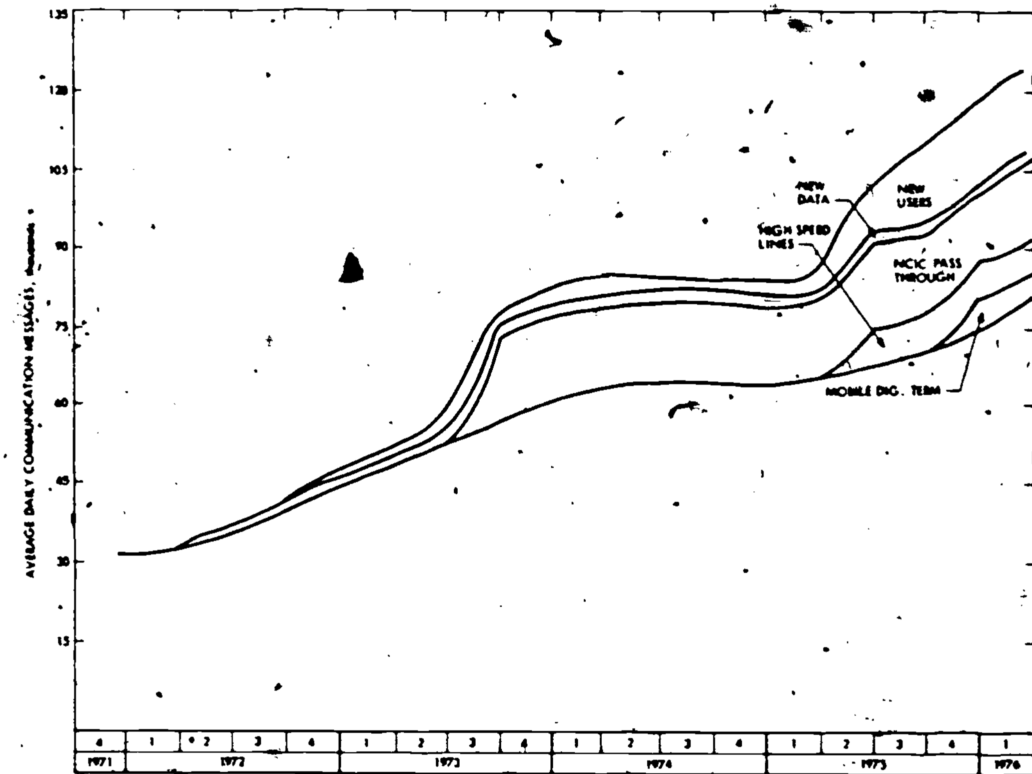
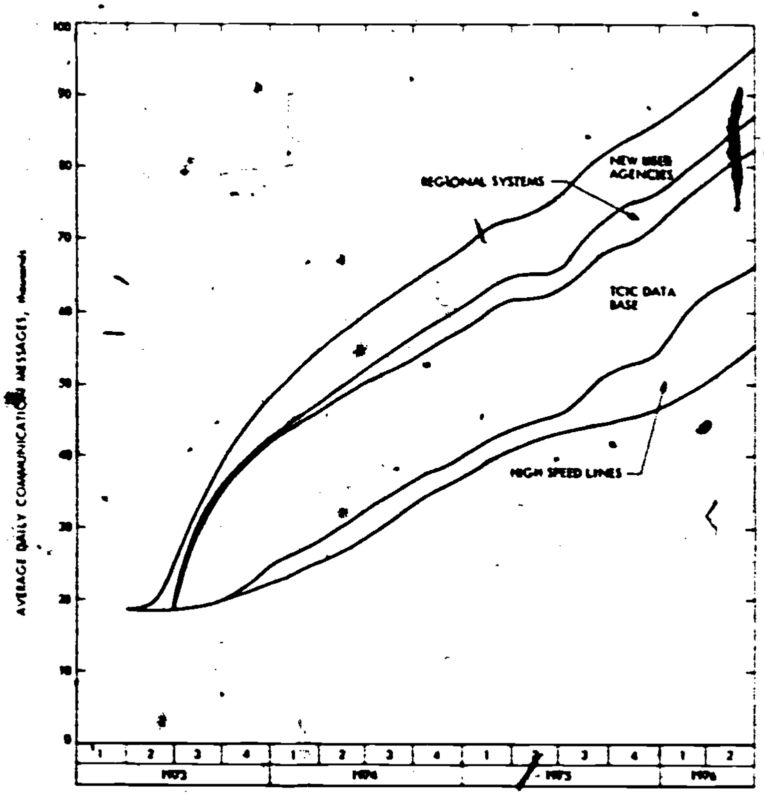


Figure 2-1. Ohio and Texas Past Communication Traffic Growth

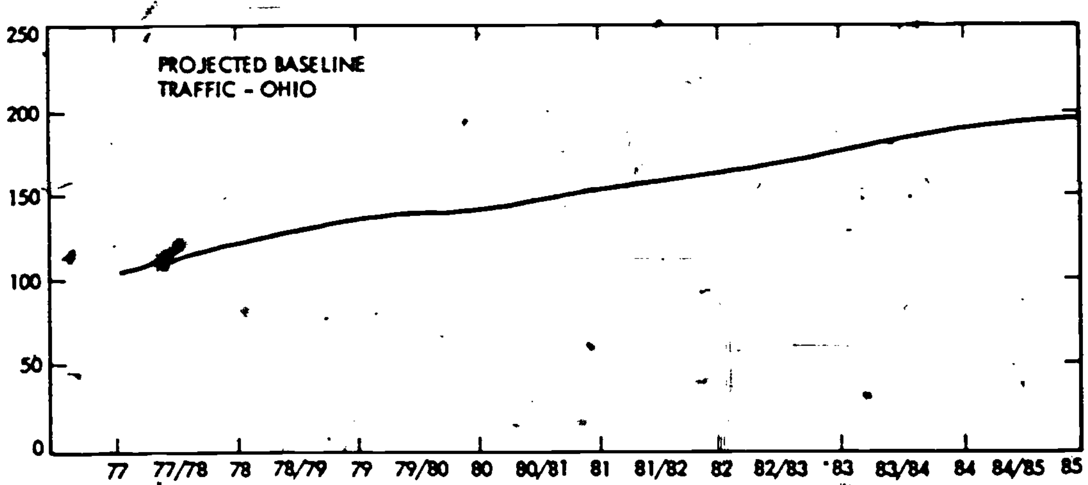


OHIO



TEXAS

Figure 2-2. Causes of Ohio and Texas Past Traffic Growth



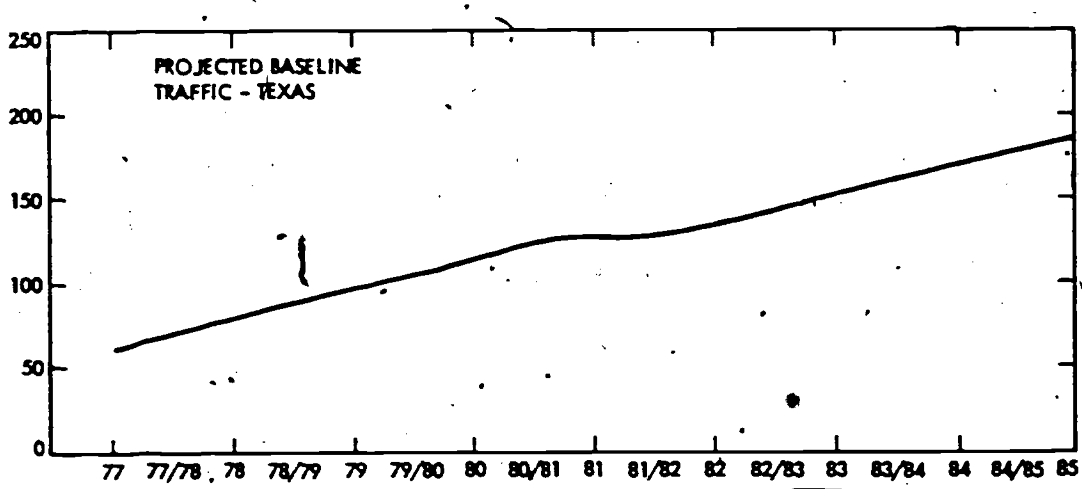


Figure 2-3. Projected Ohio and Texas Baseline Traffic Growth
(Average Messages/Day, thousands)

25

Table 2-1. Future Traffic Increases due to Communication System Improvements (Units are Average Communication Messages per day.)

Time Period	New Users		High-Speed Lines		Regional Information System		Mobile Digital Terminals 1/		Message Handling	
	Ohio	Texas	Ohio	Texas	Ohio	Texas	Ohio	Texas	Ohio	Texas
77	0	0	6,000	31,300	0	1,200	0	0	0	13,800
77/78	0	7,300	6,000	0	0	2,200	0	0	0	0
78	0	0	6,000	0	0	2,400	0	0	0	0
78/79	0	0	0	0	0	1,400	0	0	0	0
79	0	0	0	0	0	1,400	0	12,800	0	0
79/80	0	0	0	0	0	200	2,400	0	0	0
80	0	0	0	0	0	600	2,400	0	0	0
80/81	0	0	0	0	0	400	2,400	0	0	0
81	0	0	0	0	0	400	2,400	0	0	0
81/82	0	0	0	0	0	400	2,400	0	0	0
82	0	0	0	0	0	400	2,400	0	0	0
82/83	0	0	0	0	0	0	2,400	0	0	0
83	0	0	0	0	0	0	2,400	10,500	0	0
83/84	0	0	0	0	0	0	2,400	0	0	0
84	0	0	0	0	0	0	2,400	0	0	0
84/85	0	0	0	0	0	0	0	0	0	0
85	0	0	0	0	0	0	0	0	0	0
Σ	0	7,300	18,000	31,300	0	11,000	24,000	23,300	0	13,800

.ection and Organization

'affic, there are no historic traffic
)f future traffic volumes. Data col-
)n on:

϶nting new data types

justice agencies for information
data bases

)f potential user agencies that could
ibute traffic

ıncertainty, and predicting future
ılarly difficult. However, an attempt
made by examining the need for the
)taining the required funding to begin
)ns such as security and privacy con-
; determined by examining functions
etermining the required information
each function.

:omplished by the use of written surveys
ion system planners from law enforcement,
ıd parole agencies were contacted
ı new data systems in their areas.
'sonnel were asked to provide insight
)ssible barriers to implementation.

to estimate the statewide traffic volume

:riminal Justice Functions

s for Each Function

:y of Functions

϶ Data Traffic Volume

ıd the frequency of occurrence of
϶ potential traffic level. This
system is fully operational. During
ıe traffic is only a fraction of what
?or this reason a factor is introduced,
factor, which ranges between 0 and 1
ll implementation.

2.1.2.3 Application of Forecasting Techniques

Key criminal justice statistics were used to determine the frequency of criminal justice functions which when combined with data requirements per function lead to the calculation of traffic volume. Arrest statistics were used to forecast CCH and fingerprint traffic, number of inmates was used to forecast OBSCIS traffic and number of court dispositions was used to forecast SJIS traffic.

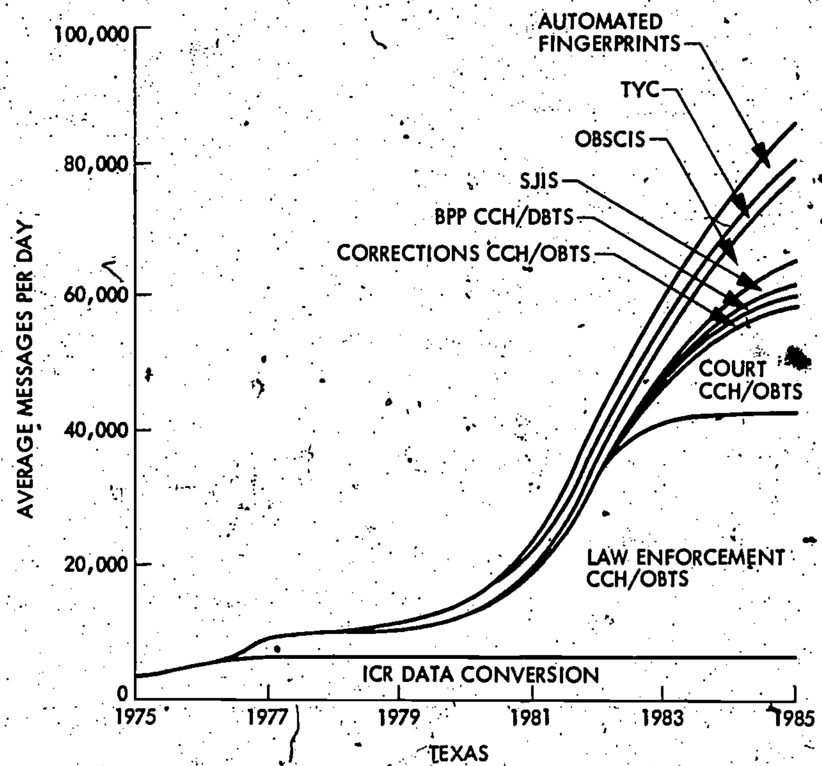
For predicting CCH traffic in Ohio and Texas, criminal justice flow diagrams were developed which described an offenders' progress through the criminal justice system. Functions along this path requiring interaction with the CCH file were identified and their frequency was determined using arrest statistics. Predictions were made of future arrest rates so that forecasts could be made of CCH traffic levels. Law enforcement, courts, corrections, and identification bureaus will all be users of the CCH data files.

Classified fingerprint traffic projections were also based on arrest statistics. It was assumed that the equipment for fingerprint encoding, classification and transmission will be available only in the largest cities since it is expensive and requires a large fingerprint volume to justify it. The number of fingerprint transactions per arrest is based on past statistics maintained by the FBI. In Texas, transmission of fingerprints will begin in Dallas-Fort Worth in 1981 and by 1985 Houston, San Antonio and El Paso will also transmit fingerprints. In Ohio, Cleveland will begin transmission by 1981 and Columbus, Cincinnati, Toledo, Dayton and Akron will be on line in 1985.

The OBSCIS data file serves the management needs of correctional institutions. Traffic is forecast based on the number of transactions with the system per inmate-day. An estimate of the frequency of inquiry or update for each inmate was provided by state correctional institutions. In Ohio OBSCIS traffic is assumed to begin in 1981 and all correctional institutions are assumed to be on line by 1983. In Texas, OBSCIS implementation will also begin in 1981 however, it is assumed that not until 1985 will all correctional institutions be on line.

The SJIS data file serves the management needs of the courts. SJIS traffic is estimated based on the number of transactions per court disposition including both criminal and civil cases in the courts that handle felonies and non-traffic misdemeanors. The majority of court management traffic will be confined to the local level, and the state level traffic will be confined to statistical reporting. Thus the number of SJIS transactions per disposition has been taken as 1.0 in both states. In Ohio, implementation of SJIS begins in 1979 and is completed in 1981. Texas SJIS is forecast to begin implementation by 1983 and to be complete by 1985.

Figure 2-4 shows new data traffic growth forecasts for Ohio and Texas. The largest component of new data type traffic will be law enforcement use of criminal history files.



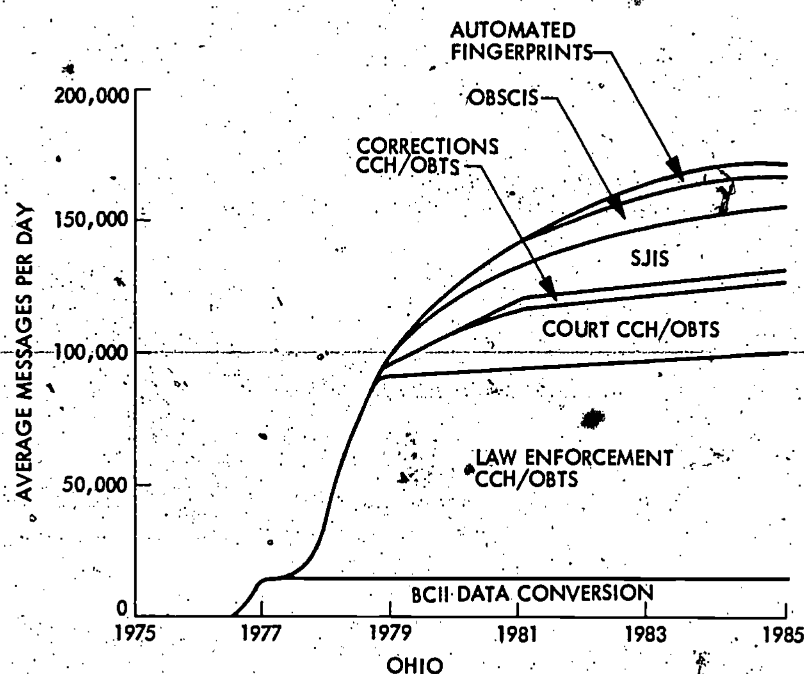


Figure 2-4. Ohio and Texas New Data Traffic Growth

2.2 FUNCTIONAL REQUIREMENTS

At the completion of state system surveys, and after sufficient interaction with state planning personnel, and prior to any specific network design activity, a document was produced specifying Network Functional Design Requirements. This document provides network performance criteria which are to be met in subsequent designs. The Functional Requirements specify what the network must do, and do not address at this level the specifics of how requirements are to be met.

The Functional Requirements document specifies characteristics and performance for the following network parameters:

- Message types
- Message content
- Message length
- Message routing
- Line protocols
- Message coding
- Error detection
- Status messages
- System terminations
- Regional switcher operation and control
- Security and privacy constraints
- Message response time
- Network availability
- Network traffic volumes

Table 2-2 lists two functional requirements of major importance for Ohio and Texas; mean response time and network availability.

Table 2-3 lists traffic requirements for Ohio and Texas for the years 1977, 1981 and 1985.

Table 2-2. Functional Requirements for Ohio and Texas Response Time and Network Availability

Parameter	Ohio	Texas
Mean Response Time (seconds)	9	9
Network Availability	0.9790	0.9722

Table 2-3. Functional Requirements for Ohio and Texas Traffic (Average Msg/Day in 1000s)

	Ohio			Texas	
Year	Leads	BMV	New Data	TLETS	New Data
1977	147	9	14	138	8
1981	214	85	142	247	24
1985	284	98	170	311	86

SECTION 3

NETWORK ANALYSIS AND DESIGN

The principal goals of the network analysis and design tasks carried out in the STACOM project are:

(1) To develop and document techniques for intrastate network design, performance analysis, modeling and simulation.

(2) Illustrate applications of network design and analysis techniques on typical existing network configurations and on new or improved configurations that meet the specified functional requirements for the States of Ohio and Texas.

Major tasks carried out in the network analysis and design phase, and the results of these activities are summarized in the following paragraphs.

3.1 DEFINITION OF ANALYSIS AND MODELING TECHNIQUES

A task was undertaken to define and develop specific analysis and modeling tools for general use in intrastate systems. The principal tool developed is the STACOM Communications Network Topology Program. This program, written in FORTRAN V and implemented on a UNIVAC 1108 computer under the EXEC-8 operating system, enables a user to find least cost multidropped statewide networks as a function of traffic level demands and other functional performance requirements.

The major inputs to the program are:

(1) Traffic levels at each system termination on the network,

(2) Desired response time at network system terminations,

(3) Line tariff structures.

(4) Locations of system terminations using Bell System Vertical Horizontal (V-H), coordinates.

(5) The number of desired regional switching center, (RSC), facilities. RSCs serve system terminations in their defined regions and are interconnected to form total networks.

Principal outputs of the topology program are:

(1) Line capacities and layouts servicing system terminations,

(2) Fixed and annual recurring costs for lines, modems, and service terminals. RSCs are priced separately.

(3) Line performance characteristics such as average line utilizations and mean response times.

A second major analysis technique enables network designers to determine the reliability and/availability of network configurations produced by the topology program.

Finally, a network response time model, used in the topology program is also useful in understanding present and future performance requirements for switching and/or data base computers in the network. This is true because the response time model involves a queueing analysis which includes queueing times encountered at computer facilities.

3.2 ANALYSIS OF EXISTING NETWORKS

This task developed and applied design and analysis tools to determine the extent to which existing statewide networks conform to state functional requirements. Areas of discrepancy are noted as follows:

3.2.1 Existing Ohio LEADS Network

The LEADS Network presently consists of ten, 2400 Baud line configurations serving 102 Ohio State Patrol Offices and twenty, 150 Baud multidropped lines serving 287 Sheriff and Police Departments. The network also provides lines for the Lucas County, (Toledo), NORIS System, the Cleveland P.D., the Hamilton County (Cincinnati), CLEAR System, NLETS and the NCIC.

The present network meets all Functional Requirements for the State of Ohio with the exception of response times on the low speed lines and on the high speed lines during peak traffic loading hours. Figure 3-1 shows present mean response time performance for the 2400 Baud lines. Figure 3-2 shows present mean response time performance for the 150 Baud lines. The STACOM functional requirement goal for mean response time is 9 seconds.

3.2.2 Existing Texas TLETS Network

The present TLETS system serves 431 law enforcement agencies consisting of police departments, sheriff offices, and State Department of Public Safety offices. The TLETS network is topologically distributed from three regional switching centers located in Garland, Austin and San Antonio. Terminals on the network are served from these switchers by 75, 110 or 1200 Baud multidropped lines. Network users have access through the Austin Switcher to data bases located in Austin consisting of the TCIC, LIDR and MVD data bases.

The present network meets all functional requirements for the State of Texas with the exception of response times on the 75 and 110 Baud lines, response times on 1200 Baud lines during peak traffic loading, and the TCIC/LIDR data base availability.

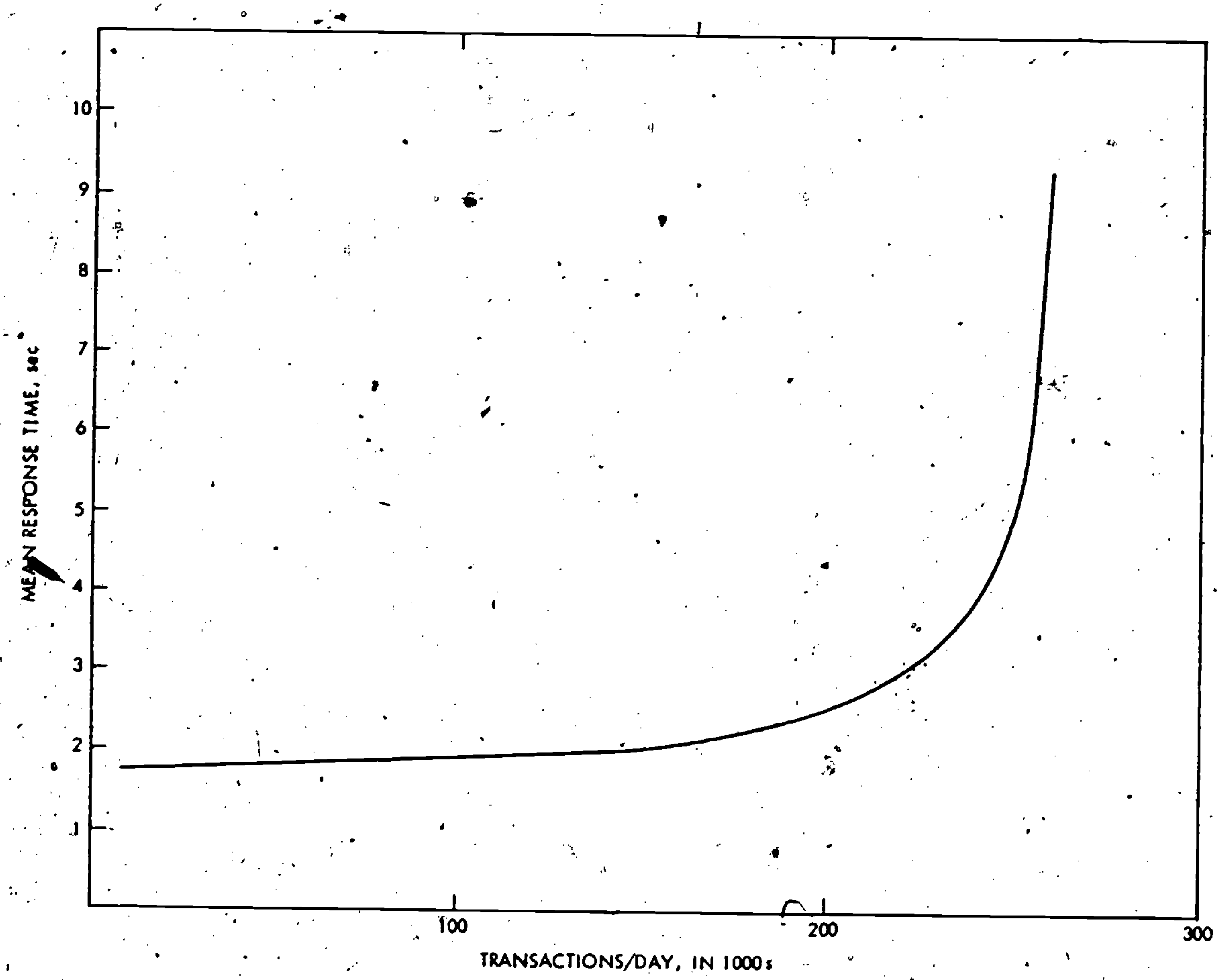


Figure 3-1. Existing LEADS Network Response Time vs Throughput--2400 Baud Lines

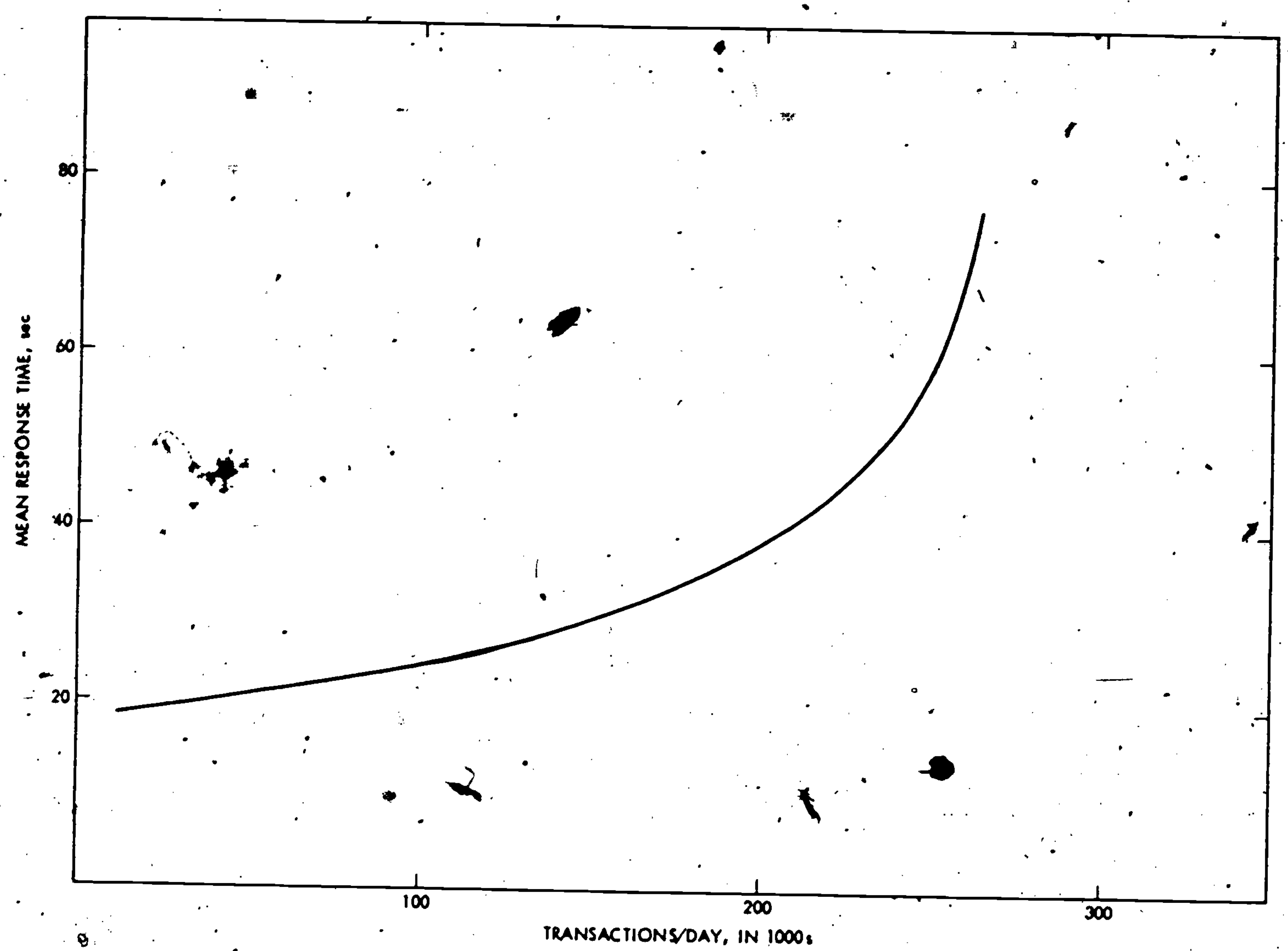


Figure 3-2. Existing LEADS Network Response Time vs Throughput—
150 Baud Lines

Figures 3-3, 3-4 and 3-5 show present mean response time performance for the 1200, 150 and 75 Baud lines respectively. The STACOM functional requirement goal for mean response time is 9 seconds.

The present system availability is calculated at 0.915 which corresponds to 122.5 minutes of outage per day. Improvements in the TCIC/LIDR data base such as an MTTF of 145 hrs and an MTTR of 1.7 hrs would result in a system availability of 0.974 which meets the functional requirement goal.

3.3 GENERATION OF NEW OR IMPROVED NETWORKS

After specific studies of interest were identified with state personnel, STACOM design and analysis techniques were employed to study statewide network configuration alternatives, (options), and additional tradeoff studies of interest.

3.3.1 Ohio Network Studies

In the State of Ohio, four basic network options were considered for the LEADS system. These involved determining cost and performance measures under the Multi-Sehedule Private Line, (MPL), tariff for LEADS configurations employing from zero to three RSCs in addition to the switcher and data base facility in Columbus. The four options were:

- Option 1 - switcher and data base located in Columbus (one region).
- Option 2 - switcher and data base located in Columbus plus an RSC in Cleveland (two regions).
- Option 3 - switcher and data base located in Columbus plus RSCs located in Cleveland and Cincinnati, (three regions).
- Option 4 - switcher and data base located in Columbus plus RSCs located in Cleveland, Cincinnati and Toledo, (four regions).

Four more network options were studied in Ohio involving the possible integration of BMV and New Data Networks with the LEADS Network. These options were:

- Option 5 - costs for maintaining separate LEADS and BMV networks.
- Option 6 - costs for integrating the LEADS and BMV networks into a single network.
- Option 7 - costs for maintaining separate LEADS and New Data networks.

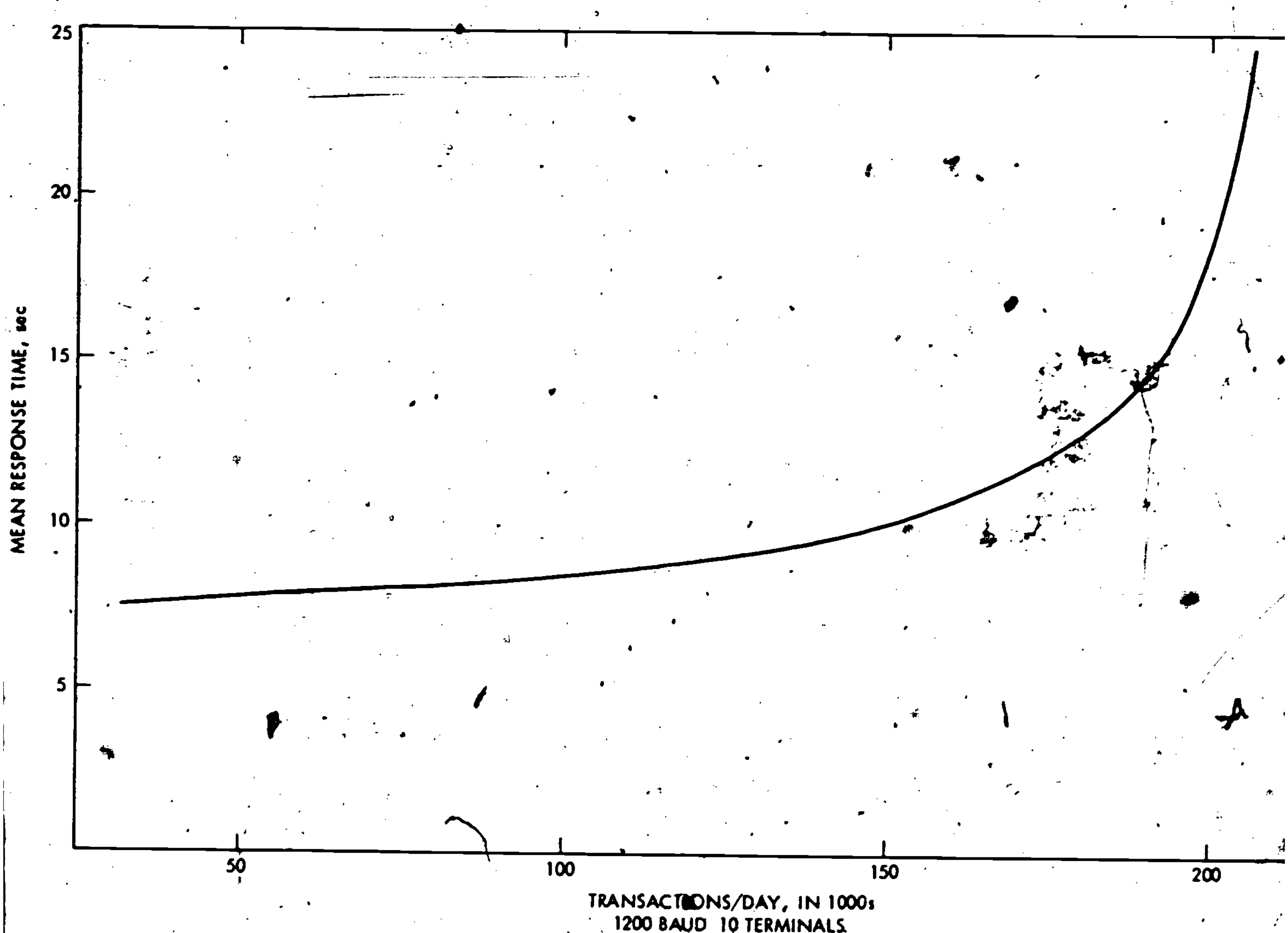


Figure 3-3. Texas 1200 Baud Network Mean Response Time to TCIC

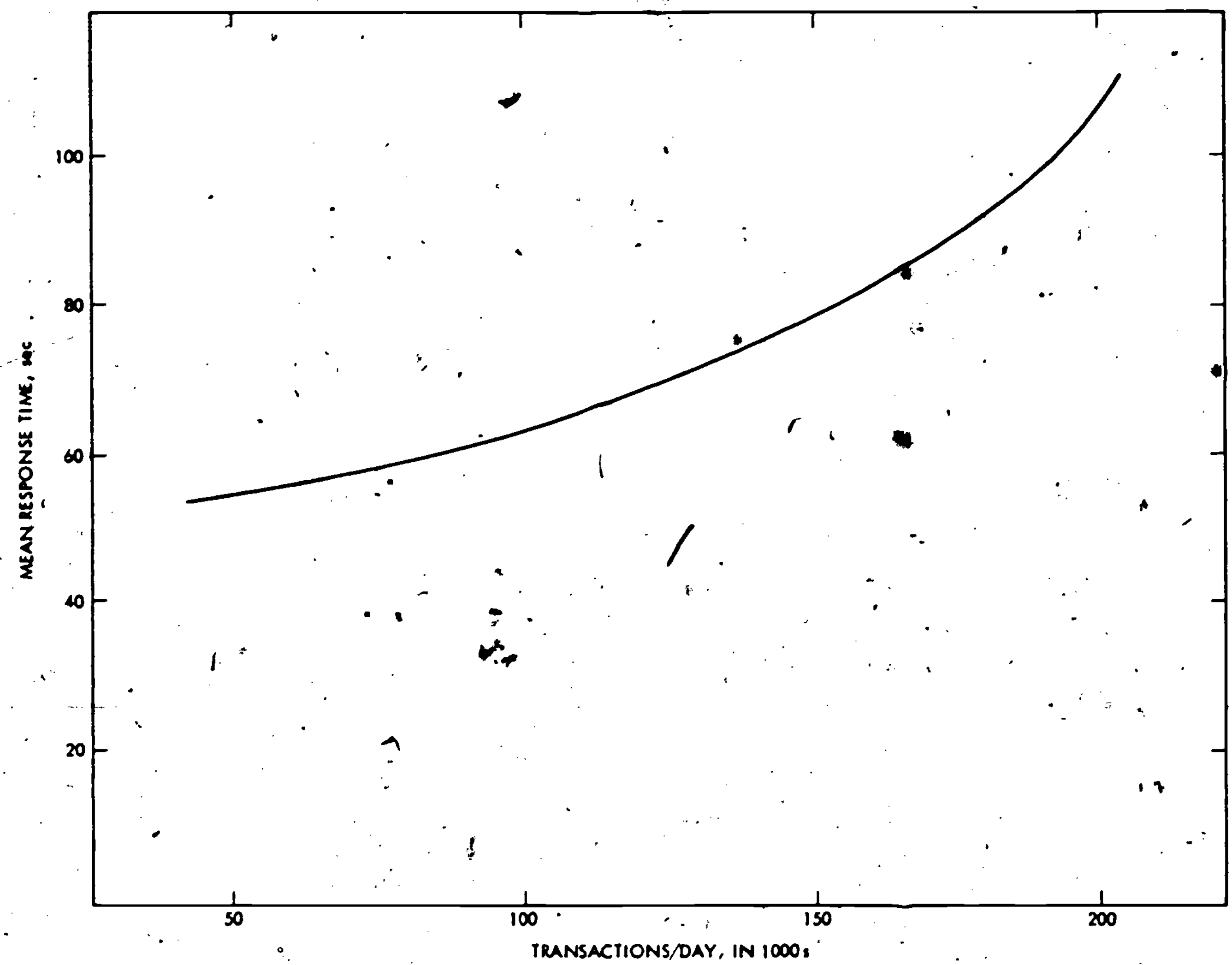


Figure 3-4. TLETS Mean Response Time 110 Baud Lines

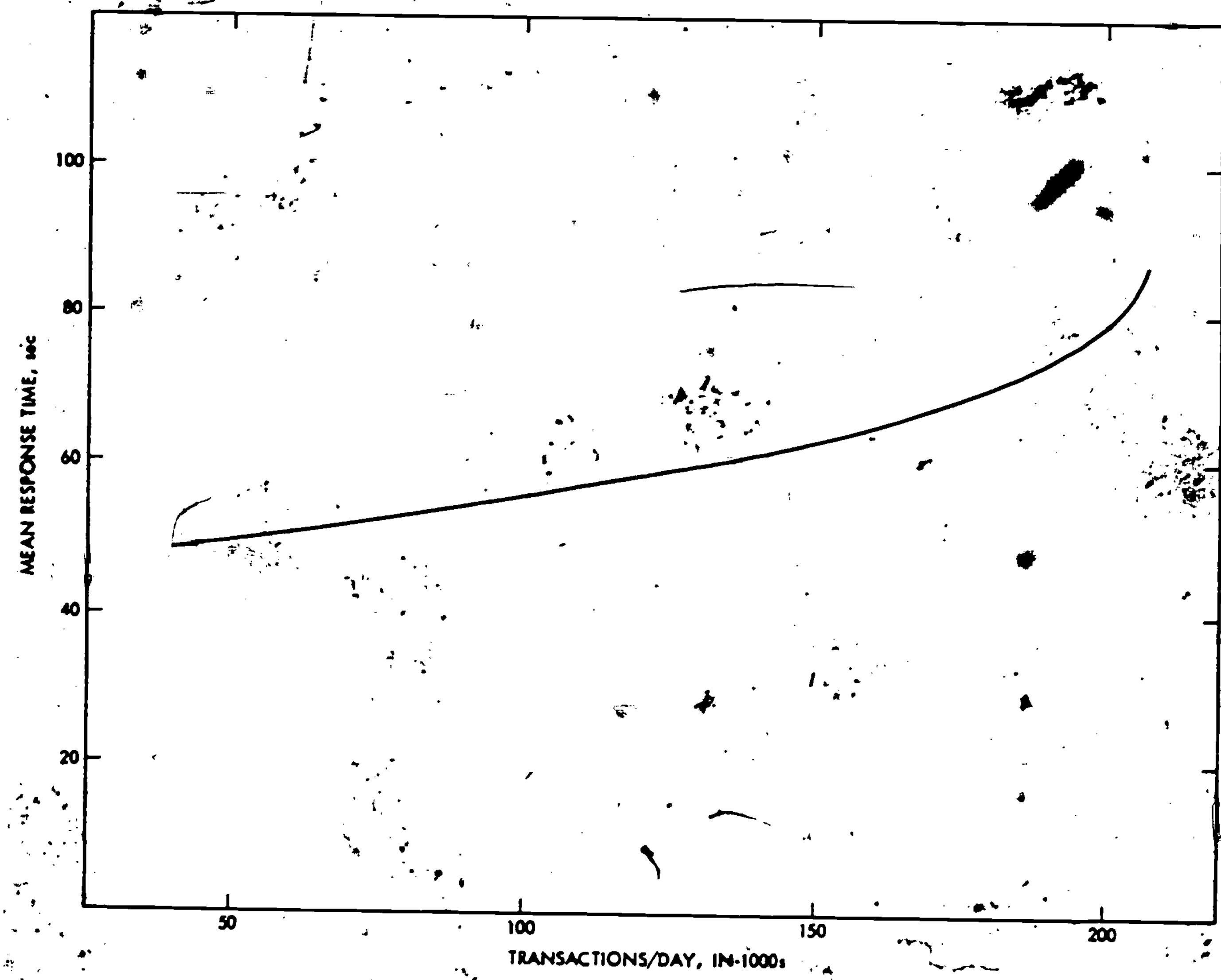


Figure 3-5. TLETS Mean Response Time 75 Baud Lines

Option 8 - costs for integrating the LEADS and New Data networks into a single network.

Two additional network performance studies carried out in Ohio included consideration of LEADS network cost increases as terminal response times are reduced, and an inquiry into the impact on network cost and performance due to adding digitized classified fingerprints as a traffic type to the LEADS system.

3.3.2 Ohio Study Results

Figure 3-6 summarizes total eight-year costs for options 1 through 4 and shows an eight-year cost estimate for continuation of the present LEADS system. The least cost LEADS Network is a single region configuration with a switcher/data base facility located in Columbus. This network is depicted in Figure 3-7. The single through four region STACOM Networks all meet Ohio Functional Requirements.

Eight-year cost tradeoffs between integrated and separate BMV and LEADS networks are shown in Figure 3-8. There are no meaningful cost savings to be realized through the integration of LEADS and BMV systems if the integrated network is priced with the MPL tariff. If the integrated network could be priced as an intrastate network, an eight-year cost of approximately $7 million would result. Figure 3-9 shows the STACOM optimized BMV network under an intrastate tariff and Figure 3-10 shows the integrated BMV and LEADS network under the interstate MPL tariff. Results are very dependent on the definition of intrastate and interstate networks. Change in these definitions would necessitate additional analysis.

Figure 3-11 presents initial and annual cost estimates for separate versus integrated LEADS and New Data Type Networks. There are no significant cost savings to be realized through the integration of New Data Types into the LEADS system over maintaining separate networks for an eight-year period.

Figure 3-12 presents results of the response time cost sensitivity study. LEADS network response times for the STACOM/OHIO single region case can be reduced from 9 to 7 seconds before additional costs are incurred. Reduction to 6 seconds increases annual line costs approximately 2%. Reduction to 5 seconds increases annual line costs approximately 13%.

Finally, digitized classified fingerprint data can be added to the LEADS network as specified in this report without compromising performance of the STACOM/OHIO LEADS System.

These results assume that the mean service time per transaction in the Columbus switcher/data base computer is immediately reduced to 470 ms. In 1981 the required mean service time per transaction is 425 ms and in 1985 340 ms is required in order to meet functional requirements for traffic growth. A 4 X 4 processor (4 central processing units) configuration is called for in 1981.

ost -- 1978 Through 1985 Options
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Ohio

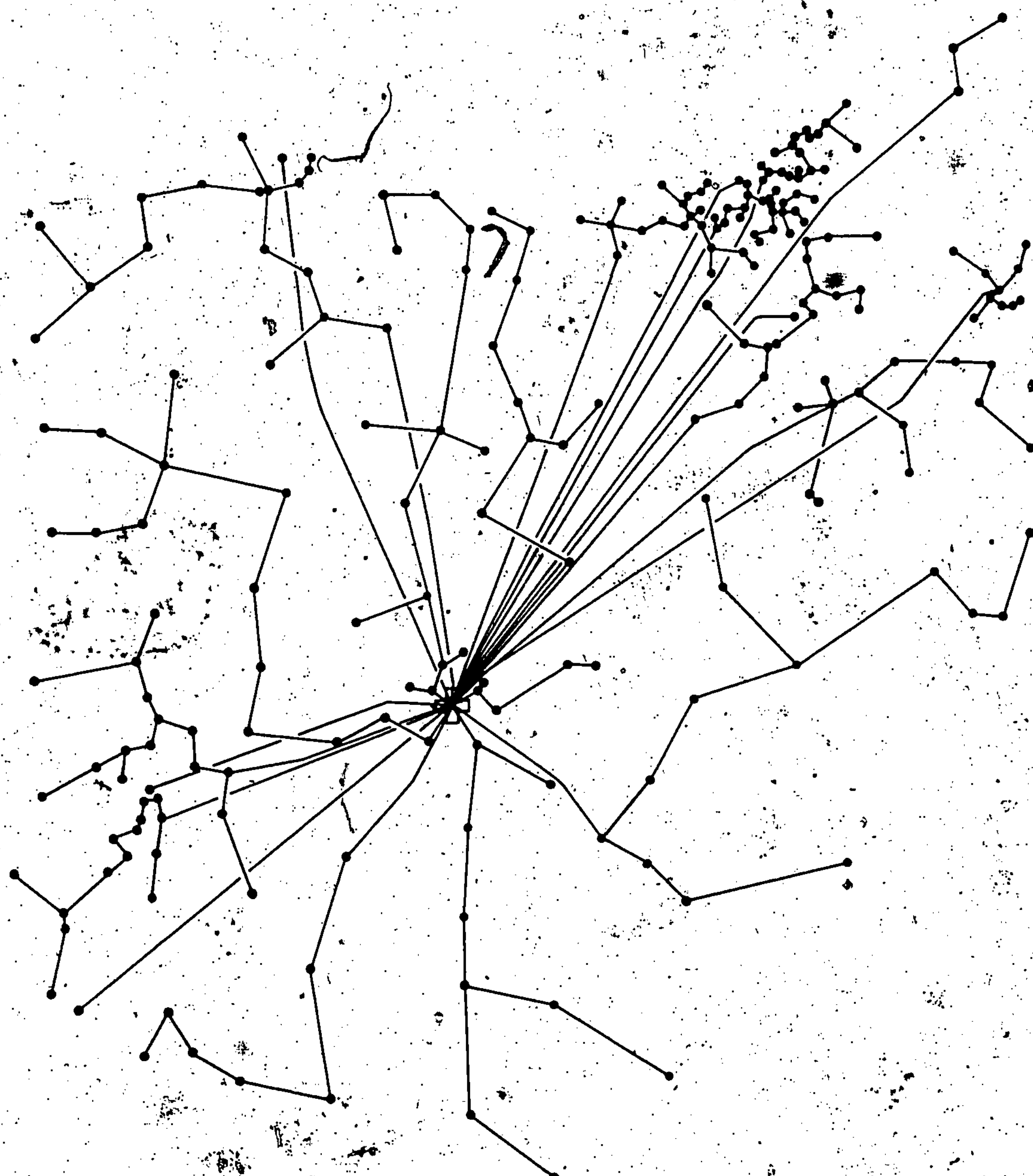


Figure 3-7. Single Region LEADS Network

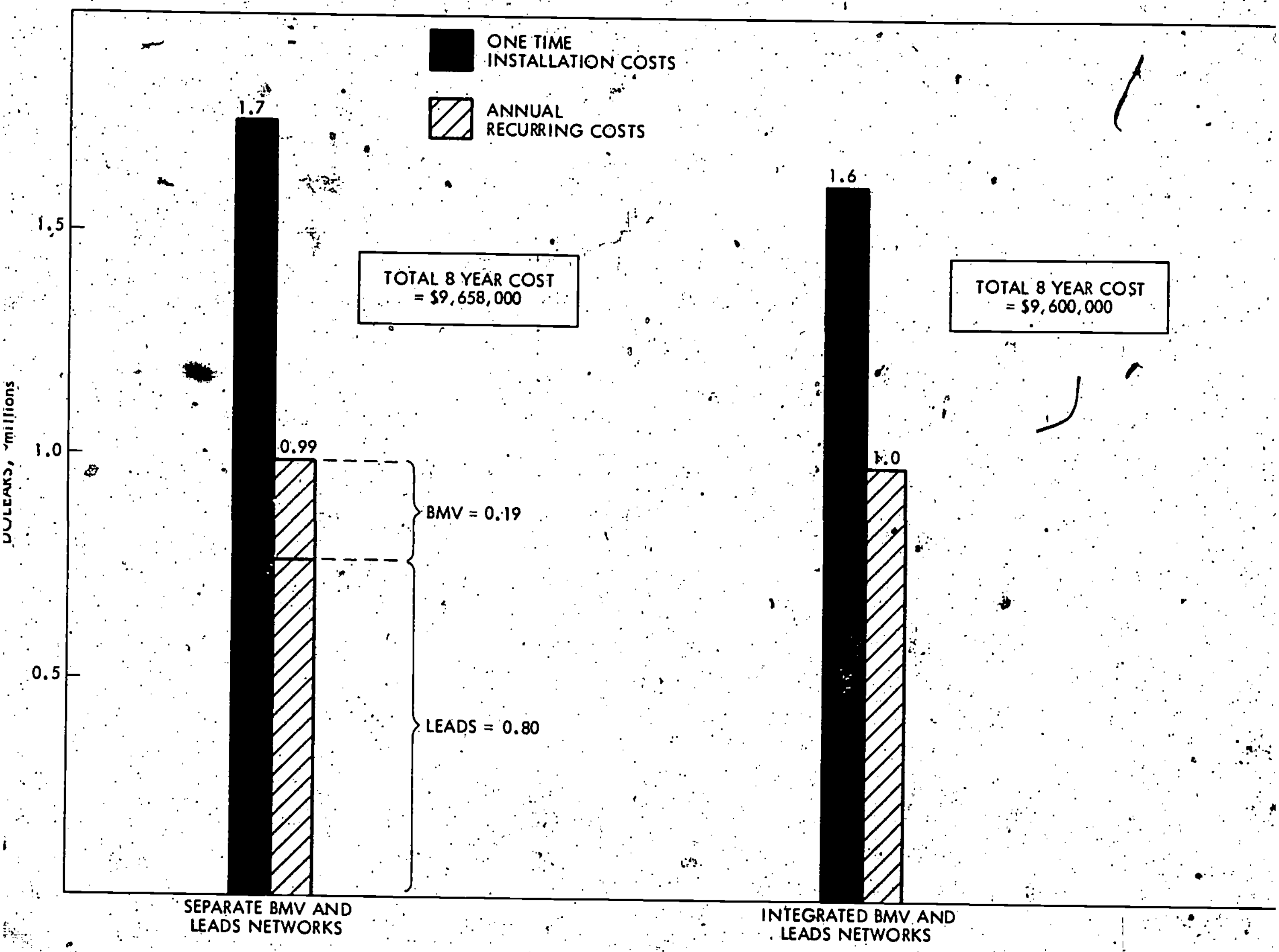


Figure 3-8. Separate vs Integrated BMV and LEADS Network
Ohio

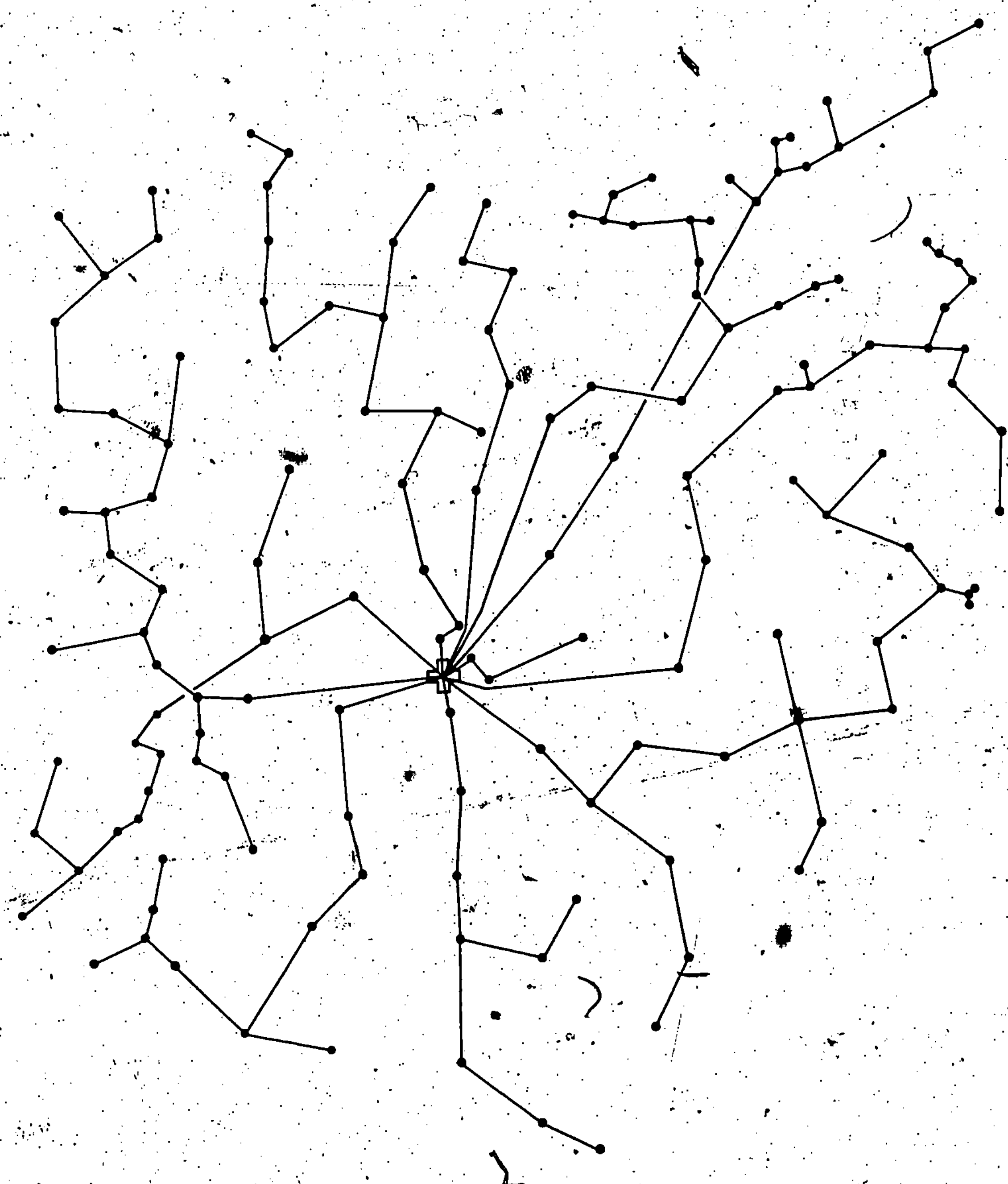


Figure 3-9. BMV Network

Figure 3-10. Integrated LEADS and BMV Network

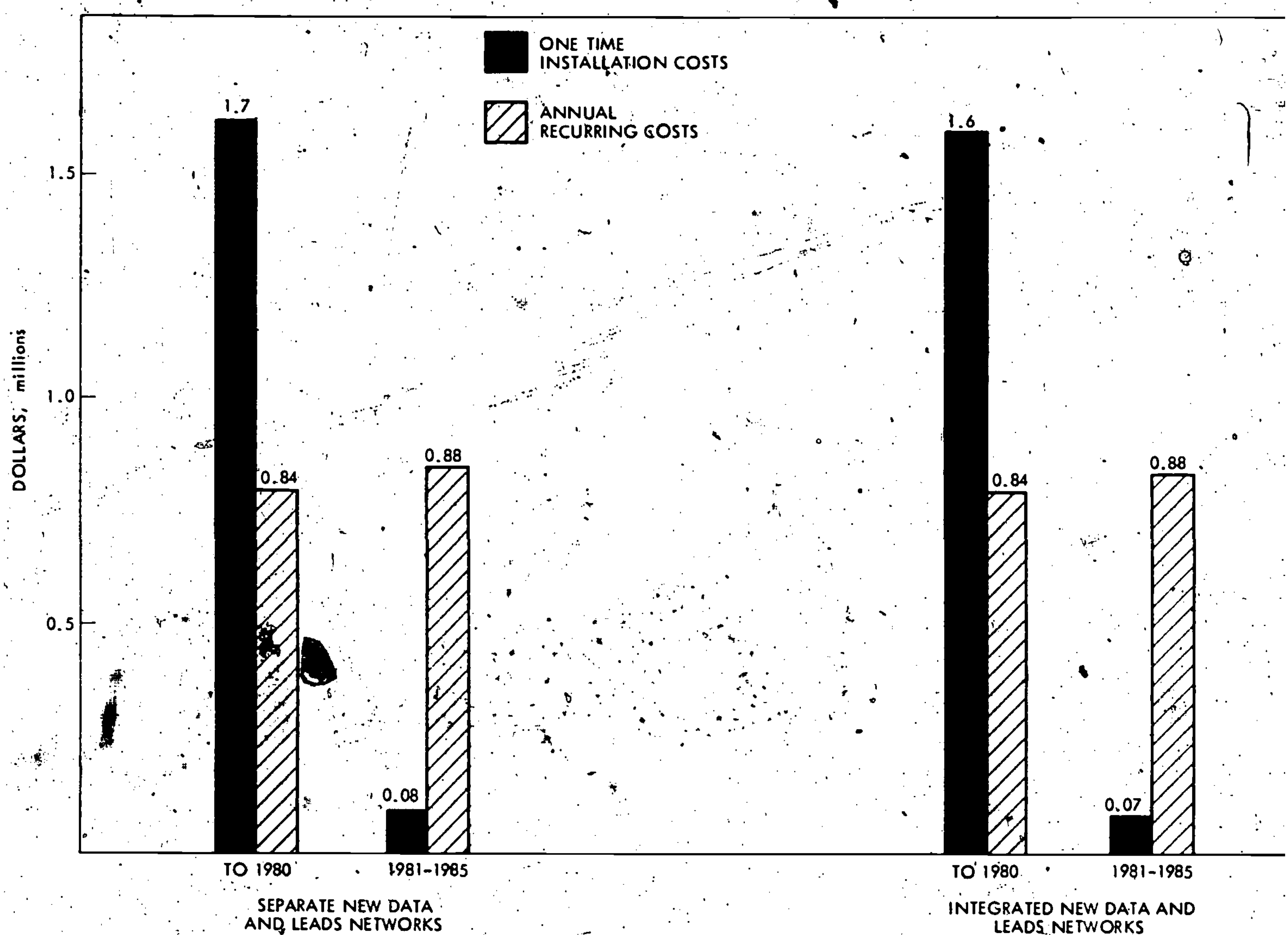


Figure 3-11. Separate vs Integrated New Data and LEADS Network for Ohio

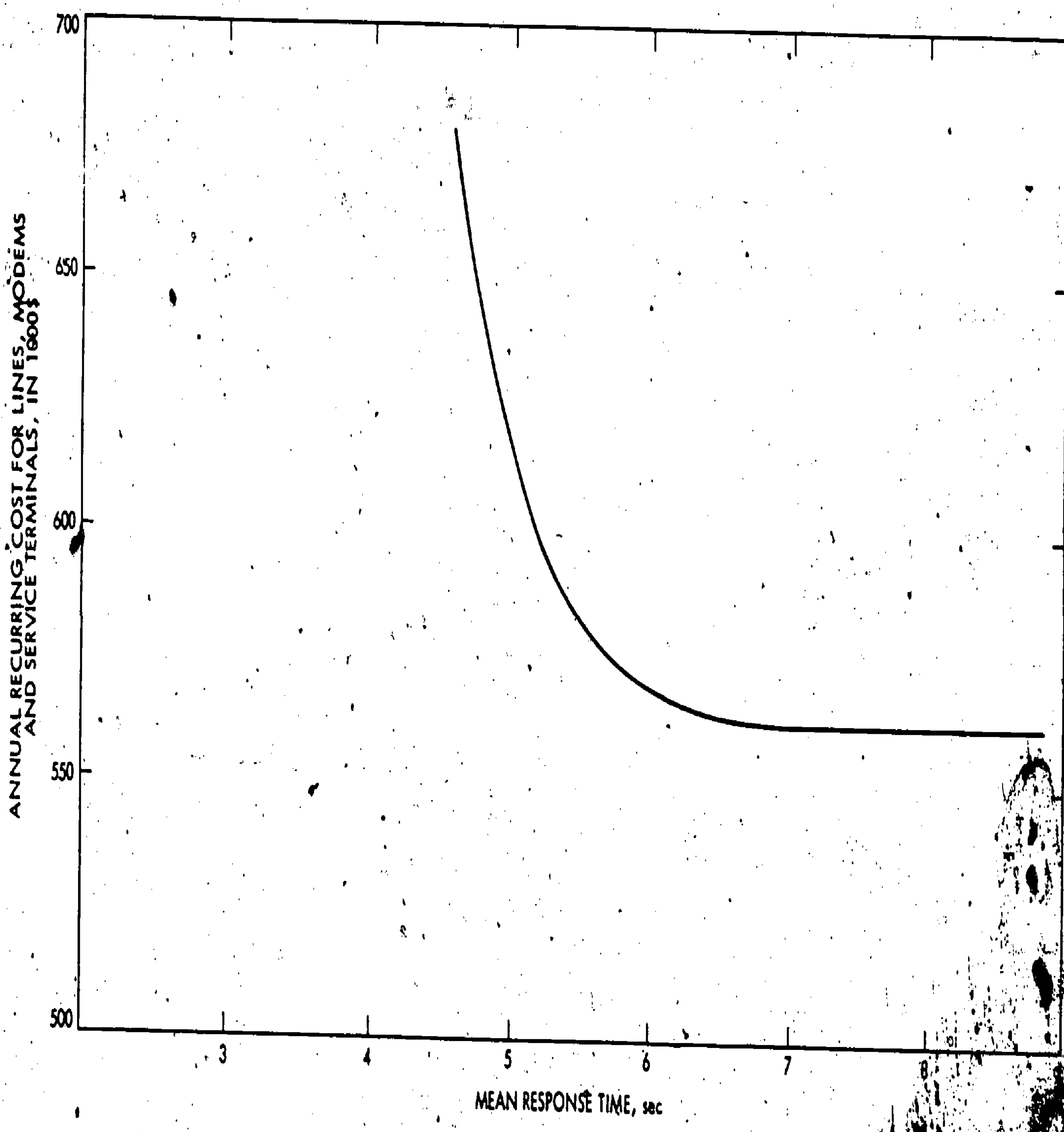


Figure 3-12. Recurring Line Costs vs Mean Response Time

3.3.3 Texas Network Studies

In the State of Texas, three basic network options were considered for the TLETS Network. These involved the study of cost and performance measures for one, two and three region networks as follows:

Option 1 - a single switcher located in Austin (one region).

Option 2 - a switcher located in Austin and a second RSC located either in Dallas, or Midland, or Lubbock, or Amarillo (two regions).

Option 3 - a switcher located in Austin, and a second RSC located in Dallas with a third RSC located either in Houston, or San Antonio, or Midland, or Lubbock, or Amarillo.

Two additional options were studied involving the possible integration of New Data types in Texas with the TLETS as follows:

Option 4 - costs of maintaining separate TLETS and New Data networks.

Option 5 - costs of integrating the TLETS and New Data networks into a single network.

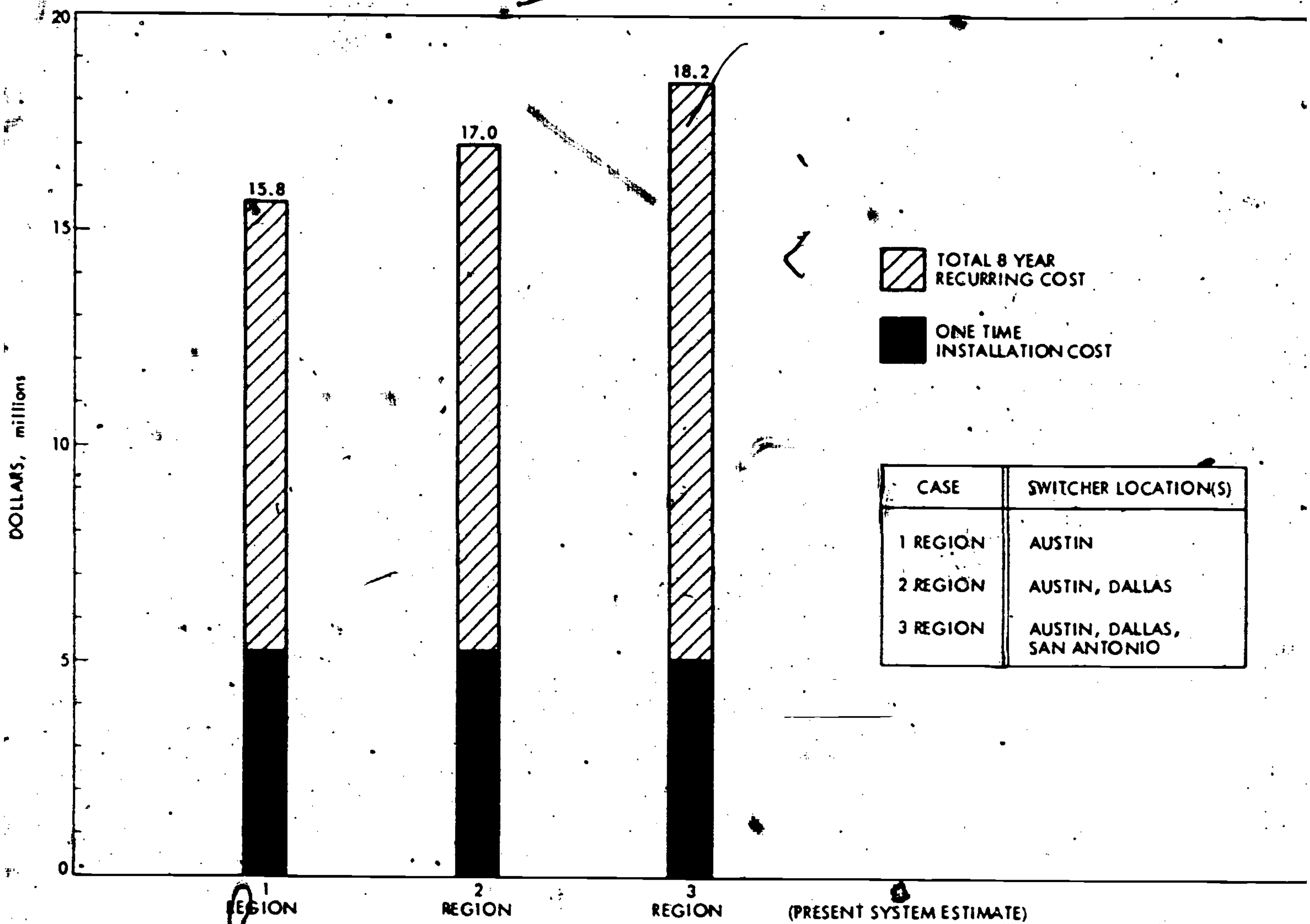
Three additional network studies were considered, (1) network cost increases as terminal mean response times were reduced, (2) the impact of network cost and performance due to adding digitized classified fingerprints as a data type to the TLETS system, and (3) the relative difference in network costs between maintaining and abandoning TLETS Network line service oriented toward the existing regional Councils of Government (C.O.G.s).

3.3.4 Texas Study Results

Figure 3-13 summarizes the least total eight-year costs for options 1 through 3. The two region case has switchers in Dallas and Austin. The best three region case employs switchers in Dallas, Austin and San Antonio, and thus represents an eight-year cost estimate for continuation of the present system. All networks meet Texas functional requirements. The single region, least cost network, is shown in Figure 3-14.

Eight-year cost tradeoffs between integrated and separate New Data Type and TLETS networks are shown in Figure 3-15. The eight-year cost savings for integrating is approximately $900,000.

Figure 3-16 presents results of the response time versus cost sensitivity study. TLETS network response time for the STACOM/TEXAS single region case can be reduced from 9 to 7 seconds before additional costs are incurred. Reduction to 6 seconds increases annual line costs



CASE	SWITCHER LOCATION(S)
1 REGION	AUSTIN
2 REGION	AUSTIN, DALLAS
3 REGION	AUSTIN, DALLAS, SAN ANTONIO

Figure 3-13. Total Comparative Cost 1978 Through 1985
Options 1 Through 3

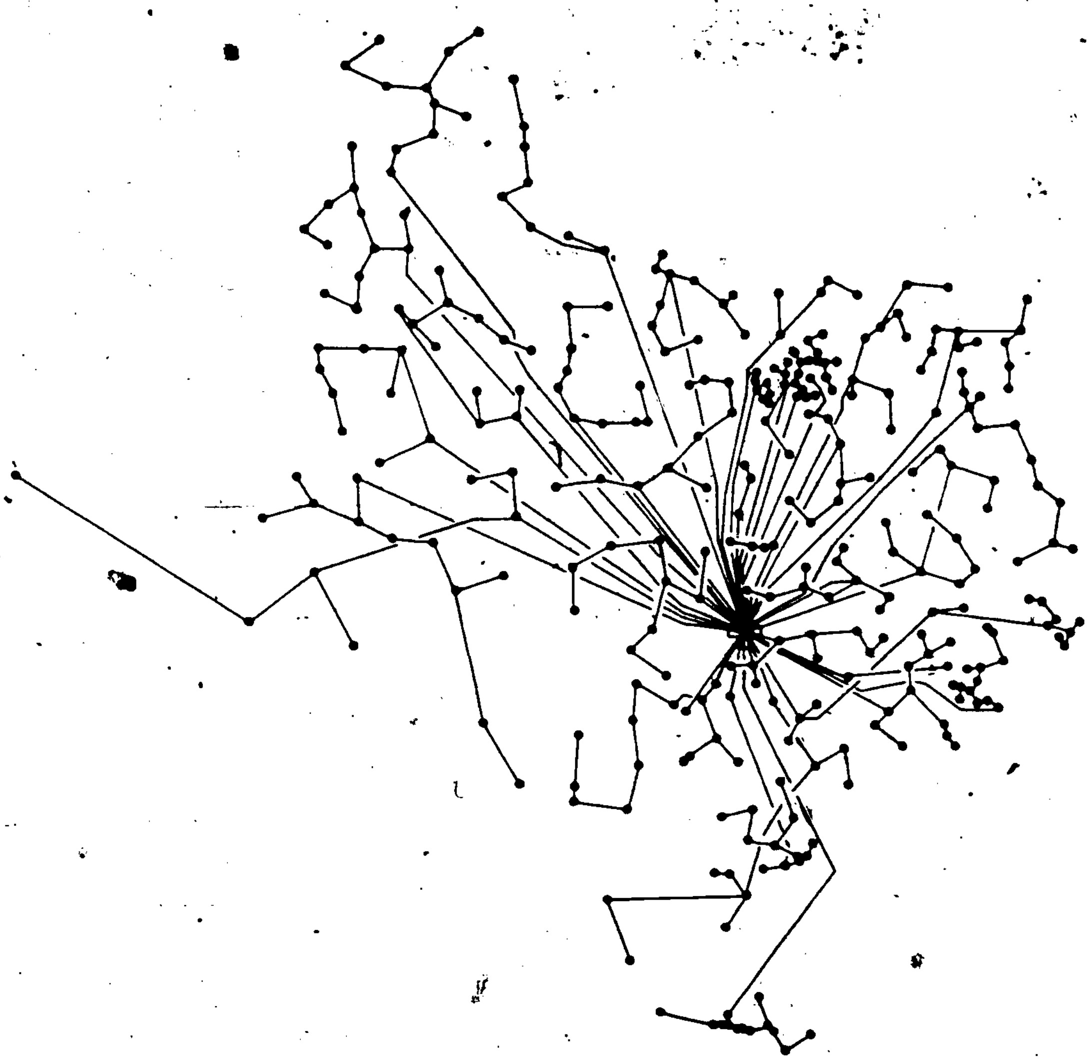


Figure 3-14. Single Region TLETS Network

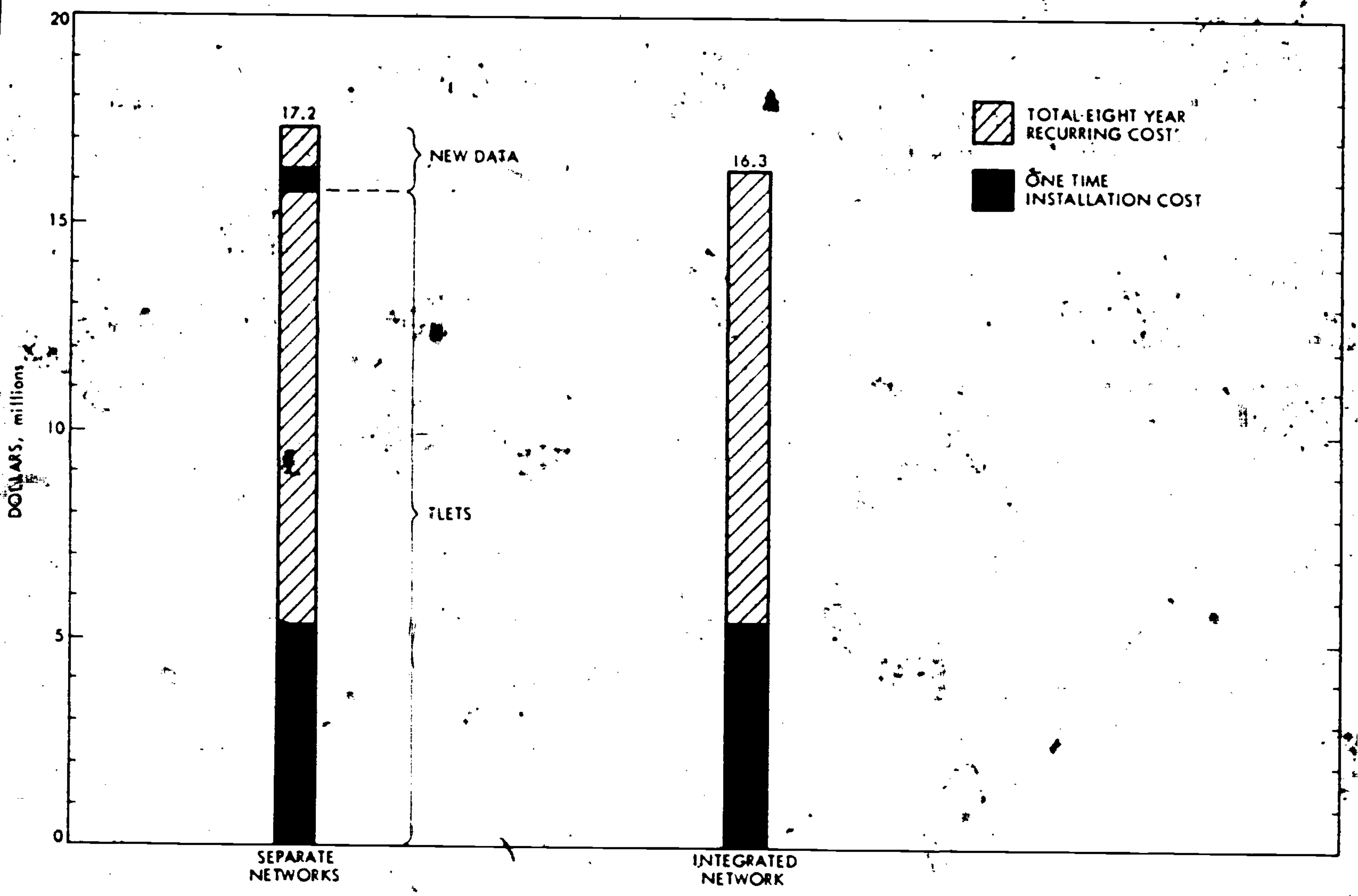


Figure 3-15. Eight Year Comparative Costs Separate and Integrated TLETS/New Data Networks

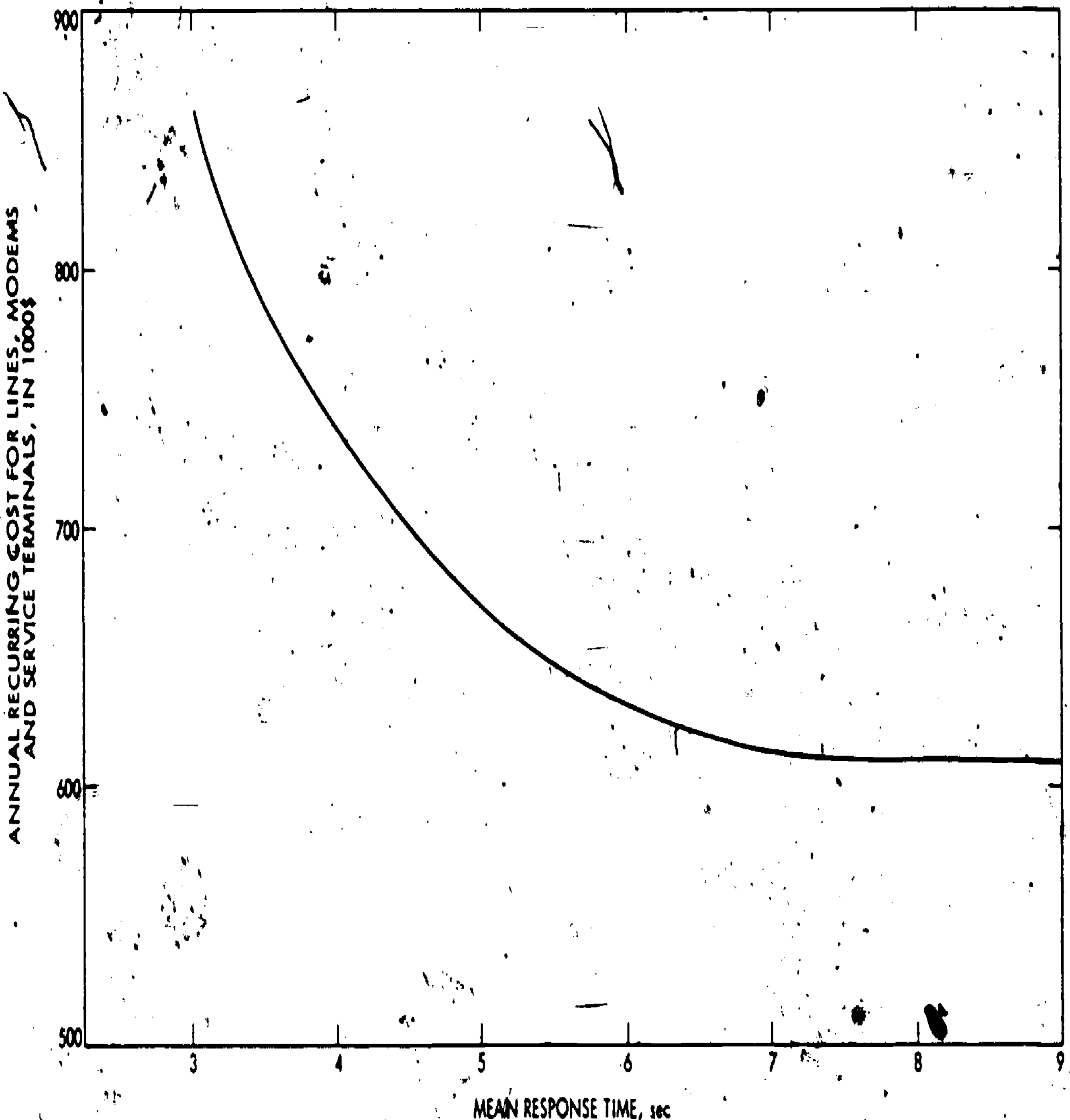


Figure 3-16. Recurring Annual Line Costs vs Mean Response Time -- TLETS Single Region

to 5 seconds increases annual line costs

fied fingerprint data can be added to the
n this report without compromising performance
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sing line cost savings due to the abandonment
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ines to the MVD Data Base from the Austin
re immediately upgraded to 4800 Baud.

ervice time per transaction in the Austin
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ervice time per transaction should be
his will be sufficient through 1985.

ervice time per transaction in the Austin
Data Base computer is immediately reduced
From 1981 to 1985 the mean service time
ction required is 200 ms.

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